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## Contents

| | PAGE |
|---|---|
| Education for Commerce | 383 |
| Theory and Practice | 383 |
| Correspondence | 384 |
| Random Shots | 384 |
| The Engineering Properties of Cast Iron | 385 |
| Indian Foundry Production | 387 |
| Catalogues Received | 391 |
| Low-Pressure Oil-Burner Design | 392 |
| Publication Received | 392 |
| Scrap Metal Difficulties | 394 |
| Refractories Research | 394 |
| Book Reviews | 394 |
| This Week's News in Brief | 396 |
| Trade Talk | 396 |
| Contracts Open | 396 |
| Company Reports | 396 |
| Personal | 396 |
| Obituary | 396 |
| Forthcoming Events | 396 |
| Patent Specifications Accepted | 398 |

## Education for Commerce

A great deal of attention is given nowadays to the technical training of youngsters entering the metallurgical and engineering industries, but much less is heard of the educational needs of those going in for the commercial side of these industries. A boy leaving school for a commercial occupation of this type is faced with considerable difficulty in looking around for the most suitable training for his new activities. The tuition available at the present time appears to be confined to the two extremes. On the one hand there are the so-called commercial colleges, which turn out an annual crop of shorthand-typist-book-keepers with but little conception of the basic principles of commerce, while at the other end of the scale there are now a number of University courses in commerce, applied economics, and business administration. For the average intelligent secondary or public school boy, these two possible sources of training are likely to be equally useless, even if the latter is within the means of his parents. The over-involved consideration of applied economics and business management is by no means suitable for the adolescent mind with no actual experience of business, while the mere office arts which are sometimes taught as business methods in the former type of institution serve only to impart a certain efficiency in elementary duties in which the progressive youngster is not likely to remain interested for very long. The vocational training idea is here carried to excess at the expense of directed thinking; as well teach an architect the art of bricklaying and leave it at that.

The primary requisite of a boy taking up a commercial post is a background of ideas for the illumination of the routine work he will be called upon to carry out—a mental equipment enabling him to observe and absorb the general principles of his particular branch of commerce. Other than this groundwork, commercial education must normally be essentially a form of self education, based on the early years of office experience and carried on by individual study. Only in this way can the sound judgment and breadth of view essential to success be developed; as in any other branch of learning, organised instruction is inferior to the constant solitary efforts of the individual student who has had some practical experience and is genuinely keen to learn.

We are left, then, with the problem of providing this basis of ideas and principles as the starting point for the real work of self training for a commercial career. Viewed in this way, the task is clearly one to be faced by the school rather than by the university or the "commercial college." The agitation which is so often heard for the teaching of the office arts in secondary schools is not deserving of serious consideration, but at the same time there is much that the schools can do in the way of imparting a rudimentary knowledge of the modern world from the commercial standpoint. Economics is entirely unsuitable as a school subject, but there are certain simple principles concerning such things as the incurring of costs and the likelihood of returns, the relative costs of alternative methods of carrying out industrial operations, the functions of management in dictating policy and allocating responsibility, which might conceivably be made attractive and informative to the upper forms. Such elementary considerations of modern business might do much to give a useful impetus to further development without in any way straying from the highway of true education into the byways of vocational training.

## Theory and Practice

A prominent foundry metallurgist recently said in public that in the past industry and education had been symbolically identified respectively with the practical man and the academic man, and that the difference between the two was disappearing. We think this is true and that the technical man is replacing both. To the man on the bench or foundry floor there are many opportunities of making practical observations which become embodied in practical experience, and we have all experienced the almost uncanny insight which such men often possess. But without scientific training these observations remain unrelated. They make up a complex of experience which is very valuable, but such men are apt to be misled by differences between things that happen underlying an apparent similarity and by similarities underlying apparent differences in their observations. In science, all phenomena are connected, and hence a scientific training helps not only by minimising the possibilities of such errors, but in assisting men to remember large numbers of isolated facts by grouping them and relating them to each other. But it must be admitted that science has as yet only scratched the surface of phenomena and that in the everyday practice for industry (and this concerns none so much as founding) the things that happen are far more complicated than science has up to now taken into account. This is where practical experience comes in. We think that the metallurgist of the future will

(*Concluded on page* 384.)

## Correspondence

*[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]*

### Foundry Costing

*To the Editor of* THE FOUNDRY TRADE JOURNAL.

SIR,—I quite agree with Mr. Moran that it is a very simple matter to charge scrap back from the foundry to stock at the average mixture, after these values have been obtained, or at any other figure for that matter, but I cannot agree with him as to the accuracy of this method.

A little thought is required regarding the results of such transactions and their effect on the costs and financial accounts.

So far as the costs are concerned we find that due entirely to the decrease (or increase) in the foundry's own scrap price, two castings off the same and in metal of the same analysis, cast on two different days, show different costs.

I am sure that most will agree that this is not a fair thing and that cost comparisons are made very difficult.

As regards the financial accounts, it is obvious that, again due to the difference in prices of scrap returned to stock, either a profit or a loss will be made on the stock figures.

This profit or loss should, in my estimation, have been absorbed in the costs, and would have been had a standard figure been used for scrap returned.

Candidly, I cannot see any good-enough reason why the average mixture values should be used, and I state that to use different values for exactly the same material, when supply and demand on the market remain the same, is only an internal "wangle" of figures and that accuracy and good accounting suffer thereby.—Yours, etc.,

"INTERESTED."

### The Oldest Grey-Iron Casting

*To the Editor of* THE FOUNDRY TRADE JOURNAL.

SIR,—A question that has long been playing hide and seek, in my mind, has now, after reading "Wealden Iron," crystallised itself in these words:—

"What and where is the oldest piece of cast iron?"

At the Wye Valley Rapids Hotel, at Symonds Yat, there is a grate back, about 5 ft. by 4 ft., with fleur-de-lys decorations, the letters B.E.A., and the date 1655, all cast iron. This is the earliest piece that I have seen myself.

In that extremely interesting volume, "Wealden Iron," by Mr. Ernest Straker, the author quotes on page 40:—

"There is in existence a letter dated September 17, 1415, from the Town Council of Strassburg to the Council of Freiburg, referring to an ironfounder."

On the same page this author says:—

"The earliest use of cast iron took place in France."

Again, on page 24, there are these very interesting sentences, referring to the method of making wrought iron:—"It should be noted that the iron was never actually fluid, but only of a pasty constituency. If by accident too great a heat was used, a product similar to cast iron was occasionally made and rejected, as they had no knowledge of how to re-convert it. This appears sometimes among the refuse."

A great deal of iron-rich cinder was used by the Romans in the roads of Britain, and is still *in situ* in many places.

But my question is about the oldest piece of cast iron consciously cast with a mould ready to receive it. There is at the Rotunda Museum at Woolwich a mortar probably cast about A.D. 1425. Mr. Straker considers this as probably one of "the earliest known specimens of cast iron in that form"—in the work referred to above he gives an illustration of this piece of ordnance, which had a cast wire* and was bound by wrought bands.

There is a cast-iron grave slab in existence which some claim to be 14th century, and another slab actually dated 1591. But I think there should be somewhere in France or Germany a grate back of cast iron earlier than any of the above castings, which are all in England.

I wonder if any of your readers can give an answer to my question? At the moment Mr. Delport is kindly making some inquiries for me in France. In France cast-iron pipes were used to convey water to the Versailles Fountain at an early date.—Yours, etc.,

C. S. WILLIAMS,
Past-President, Institute of British Foundrymen.

P.S.—Cast-iron water mains were first used in the City of London about the year 1809; prior to that date, wooden pipes were employed. I would like to ask questions about those wooden pipes. Were they always elm? How were they bored? How were the lead branch pipes connected? When was the last wooden pipe used? —C. S. W.

* We are taking up with Mr. Straker the authenticity of the word "wire."—[EDITOR.]

### What is Belgian Sand?

*To the Editor of* THE FOUNDRY TRADE JOURNAL.

SIR,—A reference was made, and recorded in last week's issue, during the discussion by the West Yorkshire Branch on "Modern Foundry Sand Practice," to the effect that "Belgian moulding sand" could be taken as representing the "finest grade in existence." It should be pointed out that the term "Belgian moulding sand" can be very misleading, as there are dozens of varieties from which to choose, just as there are in this country. One grade cannot possibly be taken as the standard.

There still seems to be a tendency to look upon Belgian sand as having no equal produced in this country. Such an outlook is entirely erroneous. British moulding-sand producers have made such advance that it may be safely stated that there is no casting, whether steel, iron, brass or aluminium, moulded with imported sand, which cannot be produced equally as well and as cheaply, if not more so, as with a moulding sand produced at home.—Yours, etc.,

E. J. CRAWLEY.
General Refractories, Limited,
Genefax House,
Wicker Arches, Sheffield, 4.
December, 1934.

## Theory and Practice

*(Concluded from page 383.)*

need a scientific training, but he must get into industry as soon as possible, and garner as much as he can of practical experience, so that where science falls short he can improvise ideas based on his scientific training as to what may be really happening. None can give more help here than the practical man, for he knows whether an observed fact is usual and normal or not. Many practical men can often give suggestions of what to do in a given case but cannot give reasons. At the other extreme, the academic man can give reasons, but his experience is too limited to tell him what to suggest. The combination is a technical man both trained and experienced.

These reflections arise from the serious loss metallurgy has sustained in the loss of two such men as Saniter and Dickenson, both of whom had long experience and wisdom. Where and how are men to be produced to carry on the metallurgical industries? If experience is necessary, it would seem that the industries should encourage men to get it systematically and not let it come, so to speak, accidentally. But how to arrange it is more difficult to suggest.

## Random Shots

The Christmas mail is in from foreign parts; here is one of "Marksman's" letters:—

DEAR HON. SIR MARKSMAN,—

I am hopeful these Christmas greets arrive in time to you and mates on Foundry paper staff with special attention Hon. Editor of same. I wish all you chaps happy days from my heart bottom and would carol you mighty loud song shouts for these frivolous times if I should go by your dwellings. Unfortunate that is not a possible for account leagues of sea between us and much billow, but in thought I am making pretty prolonged humming of Christmas chants. You are please I make such thinks, isn't it not so, and shall inscribe in yule log descript announce of foreign goodwillishness. Hurrah, Sir Marksman, you are warmhearted fellow creature of favourable intents to humanity race.

It is a grievous to me I cannot arrive your shores for Christmas celebrates and junkets of pleasure but you oversee this absent, no? By to observe picturing and other illustrates of your land I shall know what you go up to on this seasonal time, for there is depict tobog and other slides on snow and ice with snowballings on widespread areas of land surface. I have belief you are accomplish skatist to circumference ice designs with much gliding and this shall greatly pleasure the onlooks by pond side. Am I presumpt, Sir Marksman, to say you shall sometime by evil chance suffer upset on ice and bump with violence your back part? This is calamity happening without joke and I háve fear you cuss pretty hard dams to make relieve of feelings. Am I write to this facts?

Am I making right concept of Christmas by your shores to cling belief you are much kissing of young English fairs below misletoe twig and no one have word to complain you shall pop off in haste? This appear pleasant pleasuring pastime and shall interlude itself with other sports to like "Blind Man's Nuts" and "Buffs in May." I think you shall also make dancing to such as Lord Roger Bart of Coverley, Lancings, Quadroons and other nimble leaps for junior and old sports to enjoy their lifes although one leg in churchyard, already half-dead what? This is not true to say English make sad pleasures, at least by Christmas, and you accept my word Sir Mark this is lie I nail to the teeth of any silly bloke who make such remark.

You are all making giftings to each other at this time and I have hear people shall crack their brains to discover what is of suitable various relates. This brain raking is much exhaust and leave humanity limp condition after festive days, but by custom of great oldness they rather die than to admit defeat of proper gift choice, and tear like maniac through shop for seeking put mind at rest. These girls and chaps on shop counter shall also live quite exhaust all Christmas Day to recover breaths after invasion from public people. These days make golden harvest for shopkeepers, but you and I Sir Marksman, are so poor as church lice when all money spent, isn't it not so? We arrive to the point yes to say Christmas is great joyfulness to look backwards and forwards, but to-day it is here, oh crikey I blow my nose for worry.

It is customal by you for second day after Xmas for Boxing but not to mean fight in ring. This is name bank day and shall hold footballing matches and other lively jauntings of easy free countrymen to you and Hon. Editor. Postmans, dustmans and other works shall come rat-tat at door to demand smiling you don't forget us and you sick smile say good boys two bobs for you shut gate as going out. Now I stop writing and bring this for posting to make sure passage to London by time of Christmas days. Sir Marksman, you are great pleasure in my thoughts.

# The Engineering Properties of Cast Iron*

By A. B. Everest, Ph.D.

[EXTRACT.]

It is, of course, a platitude to say that cast iron is a complex material, but to-day it appears from recent researches that the metal with which we are so familiar is even more complex than has been supposed. Some 8 or 10 major variables, including all the variables of composition, rate of cooling, mass of section, and so on, are now well recognised, but, in spite of all this, it is found that under any given set of conditions, the properties of a casting cannot with any degree of certainty be predicted, and it is now realised that other variables of which little account has hitherto been taken play an important part in controlling structure and properties. Such further variables include such factors as rate of melting, temperature of superheat and further variables of composition, such as unsuspected contents of gas of various kinds and the presence of elements not usually covered in routine analysis. How appreciable this last item may be is shown by the fact that in certain pig-irons there may be from ½ to 1 per cent. of such elements as nickel, copper, titanium, vanadium and even such unusual elements as arsenic and antimony. Again, with the increasing use of alloy additions, notably nickel, chromium, copper, molybdenum, etc., scrap iron is liable to an ever-increasing extent to contain appreciable proportions of these elements, which will ultimately find their way into the finished castings, adding their own influences on properties and structure. It is, therefore, suggested that some of the unexpected behaviour of iron in castings may be attributed to these further components of the metal.

### An Engineering Angle

In the present Paper the author is dealing with cast iron, principally from the engineer's point of view. The engineer is concerned with getting castings which consist uniformly of metal of the best possible quality necessary to meet his requirements. This involves two essential considerations on the part of the foundryman, which are, firstly, the production of castings consisting of sound and uniform material, and, secondly, the control over the various variables mentioned above, which is required to ensure that the metal is of the highest possible quality. The responsibility for ensuring the first of these considerations depends largely on the foundry foreman and moulder, who must, from their experience, so pour the castings as to ensure maximum possible soundness. This leaves to them the responsibility for deciding the best position for pouring the casting and the disposition of runners, risers, etc., together with such further considerations as sand control. Considerable responsibility, however, with regard to this first consideration also depends on the metallurgist, whose duty it is to see that the metal to be used for the casting is suitable for the particular work on hand, that is to say, that the iron must not show chilled or hard spots in the thinner parts of the casting, and must, on the other hand, not be porous and open in parts which are to be subject to load or pressure. It is also the responsibility of the metallurgist to bear in mind the second requirement of the engineer, namely, that the metal must be of such composition to meet as far as possible the requirements, sometimes conflicting, of the foundryman, the production engineer and, ultimately, the user.

Special complications often arise in the case of castings of varying section in which both thick and thin sections must be of suitable quality. Considerable experience has been accumulated during the past few years with regard to the influence of varying section on castings, and there is little need to-day for trouble with chilled spots on the one hand and porosity on the other if a proper control over composition and casting variables is maintained.

### Thin and Thick Sections

The author then dealt briefly with the influence of nickel as an alloy addition for equalising structure between thick and thin sections. This has been dealt with adequately elsewhere,[1] but a point which has become more appreciated as a result of recent study is that variation in structure is perhaps more inherent to the weaker and poorer-quality irons than in the case of modern high-duty irons. For example, recent work has shown[2] that in the case of irons of tensile strength, about 12 tons per sq. in. in a 1.2-in. dia. bar, the strength in a 3-in. dia. bar is only about 54 per cent. of that in the smaller bar, or, in other words, about 6½ tons. On the other hand, with an iron of about 18 tons tensile strength in the 1.2-in. dia. bar, the strength in the 3-in. dia. bar is about 66 per cent., or, in other words, about 12 tons per sq. in. This is a point of considerable importance, and is definitely in favour of the high-strengths irons as applied to castings of variable section.

In the case of the high-test irons, the principal factor required for high strength apart from control over the melting conditions is the use of compositions giving low carbon, low silicon and low phosphorus.

### Structural Control

In studying cast iron from the engineering point of view, it is a convenience to consider the metal as consisting of a matrix of high-carbon steel broken up by graphite flakes in the case of a grey iron or by massive carbides in the case of a white iron. From the point of view of strength it is clear that the graphite flakes form lines of weakness in the metal since it is a matter of common experience that in the case of coarsely graphitic irons fracture always takes place along the graphite flakes; and similarly it is recognised now that the potential strength of cast iron is the same as the strength of the steel matrix and can be given as something of the order of 40 to 60 tons per sq. in. From the point of view of strength alone, therefore, it is evident that the first requirement is of control over the size and form of the graphite and many methods have been evolved in recent times to effect this. Amongst them can be mentioned the reduction of the quantity of graphite by the use of low-carbon or refined irons and of semi-steel mixtures whilst other processes such as super-heating can be used to ensure a finer form for the graphite which separates on solidification. By the use of such methods the strength level of castings has been raised from the old-time 8 or 10 tons per sq. in. up to commercial figures of 18 to 20 tons for irons made under ordinary foundry conditions with or without the use of alloy additions to give further refinement of the graphite and further strengthening of the matrix.

Another development of special interest from the strength point of view is that of the high-test inoculated cast irons which have been described elsewhere,[3] and which are capable of giving strengths under commercial conditions and even in large castings up to 25 tons per sq. in. The author referred to a recent Paper by Pearce[4] in which a strength of 28.7 tons per sq. in. was claimed for such an iron in commercial production.

Whilst considering the question of strength, special reference was also made to the question of phosphorus content, it being emphasised that for engineering castings it was usually desirable to keep phosphorus low, since not only was phosphorus frequently associated with unsoundness,[5] but the presence of the phosphide eutectic also materially affected the strength of the metal.

Discussing other physical properties, the author dealt briefly with the relationship between quality as determined by strength and wearing properties, it being emphasised that in many castings, as, for example, for machine tools, for pumps, and for Diesel engines, the modern high-strength irons were of special value, not only on account of their strength, but on account of the combination of strength and wear resistance which they offered.

### Machine Tool Castings

Dealing in greater detail with cast iron for machine tools, the special advantage of cast iron in its ability to damp out vibration, thus ensuring for cast-iron parts a greater rigidity than was available in such alternative types of construction as welding was discussed, emphasis being laid on the inherent superiority of the iron casting.

Cast-iron crankshafts were mentioned as being of special interest, their success being attributed partly to the damping properties of the iron, but more perhaps to the high fatigue strength now being shown for cast iron.[3, 5]

The influence of heat-treatment on cast iron was considered, and it was shown that such alloy additions as nickel had a markedly beneficial effect in so modifying the treatment necessary that it was now a commercial proposition to apply heat-treatment even to complicated and massive castings. The advantages of such treatment were not only to increase hardness and wearing quality, but also to increase strength.

When sufficient alloys such as nickel and chromium were added to make the castings self- or air-hardening, then it was found that in the case of grey irons materials of extraordinarily good wear resistance were available for such applications as the automobile industry and in machine tools. Where a similar principle of making the castings self-hardening was applied to white-iron castings, then extremely high hardness figures were available and, for example, in chilled cast-iron rolls a new field of development was opened up.

The influence of higher alloy additions in forming the austenitic structures was then discussed and special reference was made to the engineering properties of the austenitic irons, these including not only very good mechanical properties, such as their good toughness, but also their other special properties such as corrosion and heat resistance, non-magnetic characteristics and their special expansion features.

In conclusion, the author stated that he realised that many of the new special and alloyed irons were expensive as compared with ordinary cast iron but, on the other hand, it was now becoming increasingly appreciated that these newer irons offered properties which were not available even in many of the more expensive materials, such as the special steels, and that on account of these special properties alone the newer irons were an economic proposition and were worthy of the consideration of every engineering designer.

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4 "Modern Cast Irons in Chemical Engineering," by J. G. Pearce. Preprint, "Chemical Engineering Group, Society of Chemical Industry," November, 1934.
5 "Report of the Cast Iron Sub-Committee of the British Cast Iron Research Association." FOUNDRY TRADE JOURNAL, June 28, 1934.

* A lecture given before the Wales, Monmouth and West of England Branch of the Institute of British Foundrymen, on November 17, 1934, at Newport.

## DISCUSSION

### Competition with Steel

PROF. W. R. D. JONES said that the details given with regard to modern cast irons raised the question as to what would be the position in the future. The author had referred extensively to the replacement of steel by cast iron, but he thought that this statement should be accepted with caution, since it would be incorrect to suggest that steels in general could be replaced by modern cast iron. With reference to cast iron, the most important considerations were the structure of the metal and the character of the graphite. Recent developments had been towards the production of "smoky" graphite, but unless the foundry practice was very good it was difficult to obtain this type of structure. To-day best results were being obtained by the use of inoculation. The addition of alloy elements, such as nickel, has broadened the scope of application of cast iron and rendered available materials which were not available years ago.

Prof. Jones said he quite agreed with a great deal of what Dr. Everest had said, but he did not like to hear such sweeping statements as were made in connection with many of the properties. Alloy and other special cast irons were often compared very favourably with what was termed "ordinary" cast iron, but the point was not that the irons should be compared with ordinary cast iron but that they should be compared with the best product of an ordinary iron foundry which can be put forward for a special application. A great deal is said about nickel in cast iron to-day, and it appears that nickel definitely gives results in iron castings which are not obtained by any ordinary method. Nickel also offers a control over the structure and is desirable for obtaining certain definite mechanical properties without which the foundry trade would find it difficult to get along to-day.

Prof. Jones added that the lecture had brought home to him the tremendous value of the research work which was being done at the present time by such organisations as the British Cast Iron Research Association and by industrial interests such as that with which Dr. Everest was identified.

### Relative Impact Values

In reply to Prof. Jones, DR. EVEREST said that with regard to the replacement of steel by cast iron, he had not intended to suggest any wholesale replacement in this direction. It was clear that for certain applications cast iron as normally accepted is not quite good enough whilst, on the other hand, steel is perhaps too good. What he had intended to convey with regard to the development of the modern irons was that the boundary line between steel and cast iron was raised so that for some parts for which steel was formerly used cast iron to-day would be sufficiently good. Examples had been mentioned in the Paper such as Diesel-engine flywheels in which the special cast iron offered several advantages once its strength had been raised to a sufficiently high level. With further reference to the question of replacing steel, it was clear that if consideration were given to such properties as shock resistance, then there could be no question of replacing steel by cast irons, since whereas the latter had Izod values as high as 60 to 100 ft.-lbs., the figure for cast iron was very low and certainly not more than 4 ft.-lbs.

With regard to the position of the ordinary ironfoundry, Dr. Everest stressed that he regarded the class of special engineering cast iron as representing a relatively small though interesting section of foundry activities. For ordinary ironfoundry work there is no need for consideration to be given to the special irons and the irons at present in use, for example, for stoves, light castings, etc., are on the whole quite good enough. It is in this class of work that tonnage is involved, and thus it happens that the high-quality engineering irons as described represented only a very small percentage of the production of the ironfoundries of the country.

With reference to the comparison of the special irons with ordinary iron, as, for example, in the case of the corrosion-resisting properties of the austenitic irons, the author wished to make it quite clear that the comparison was made against non-alloyed iron of good composition, such as would normally be used for the particular application, and in each example quoted in the Paper it should be considered that a fair comparison had been made between the new material and the best material previously available. In this connection the author would like to stress once again that with regard to the use of nickel, its addition must not be used in trying to make a bad iron good, but had its application in making a good iron better.

### Steel Liners Replaced by Cast Iron

MR. SCOTT, of Newport, said that he was personally concerned with replacing steel liners in automobile engines with alloy cast-iron liners, some of which were heat-treated to give a hardness in the range 500 to 800 Brinell, but the majority showed a hardness between 240 and 280. These liners are supplied by well-known firms, and are received $\frac{3}{32}$ in. thick and are bored down to a thickness of $\frac{1}{16}$ in. Mr. Scott confirmed that the high hardness special alloy irons were giving remarkable results, and showed very high mileages in relation to wear in automobile engines.

With regard to acid-resisting irons, Mr. Scott said that he had at the present moment work on hand in which acid-resisting steels had not given satisfactory results, but that the austenitic corrosion-resisting cast iron had been installed and appeared to be going to give better results than the more expensive steels.

In reply, DR. EVEREST said that in the case of the cylinder liners, he was glad to hear Mr. Scott's confirmation, and asserted that his own opinion was that, although design played a considerable part in engine wear, materials also had a big influence, and the modern alloy cast irons were going a long way to meet the present exacting requirements. With regard to corrosion-resisting irons, he stated that he was aware of many applications where these materials proved better than the more expensive steels, but the actual choice of material must in each case be determined by the particular conditions involved.

### A Questionnaire

DR. T. B. CROW asked a number of questions with regard to special cast irons, and these are enumerated as follow:—

(1) What is the possibility of getting smoky graphite by superheating?

(2) To what extent would cupola coke influence the question of the existence of coarse graphite? Some coke has a bad carbon pick-up. What would be a suitable coke to use?

(3) Would Dr. Everest state what relationship existed between resistance to wear and Brinell hardness? Would 400 Brinell wear twice as well as 200 Brinell?

(4) With regard to the lathe bed illustrated, was this of special hard or moderately-hard iron?

(5) With regard to Alloy N.33, mentioned with reference to corrosion resistance, what particular alloy was this?

(6) Has Dr. Everest any actual figures with regard to creep stress?

(7) Could Dr. Everest give a reference to nickel-silicon alloy iron? Also an analysis of self-hardening iron?

(8) With reference to high-test irons, was the figure of 28.7 tons per sq. in. a special result, or could such figures be regularly obtained in the foundry?

### Smoky Graphite

In reply, DR. EVEREST said that the reference to smoky graphite reopened some of the remarks made by Prof. Jones with which he was perhaps not in agreement. In his own experience, smoky or sooty graphite, which is alternatively known as eutectic graphite is generally associated with poor quality from the strength, wear-resistance and corrosion-resistance points of view, structures in which this form of graphite occurred being generally disappointing. For further information on this subject, reference was made to the Paper by Dr. Nipper, who is associated with the Giesserei Institute, Aachen, Germany, before the Institute's Manchester Conference earlier this year. Dr. Everest said he thought that perhaps both Prof. Jones and Dr. Crow had in mind finely dispersed graphite as obtained on inoculation rather than the sooty graphite mentioned; and, replying to Dr. Crow, he stated that he agreed that such fine graphite could be developed among other methods by the use of super-heating, and in this connection he stated that he was aware that, according to some, refinement was the result of solution of the original coarse graphite in the iron. The use of steel mixtures also helped in this direction.

With regard to the question of coke, the important point was the question of its reactivity. This was a matter under consideration at the present time, and the evidence seemed to be rather conflicting. In the author's own opinion, however, it would appear that where melting high-steel charges for high-test irons one wanted a short, quick-melting zone, which one would expect to get with a highly-reactive coke.

### Wear Resistance

The relationship between wear and Brinell hardness would depend entirely on what was understood by wear. Under conditions of abrasive wear, as met in many machine constructions, the author had found that there was a direct relationship between hardness and wear-resistance. It should be remembered, however, that in many cases as, for example, in automobile cylinders, questions other than penetration of the metal under abrasion came in, and, for instance, in cylinders an important factor was corrosion. With reference to the lubrication afforded by the graphite flakes, he appreciated that this was an important point, but he believed that with normal types of graphite the lubrication would take place whether it was fine or coarse. Lubrication is not to be expected with smoky-type graphite, and might thus perhaps account in part for the bad-wearing qualities of materials containing this type of structure. Referring to the lathe bed which had been illustrated, this, the author stated, was a low-alloy iron with a Brinell hardness of 230 to 240. N.33, the author also stated, was an austenitic iron of the "Ni-Resist" type.

With reference to creep stress, the author referred Dr. Crow to the "Symposium on Cast Iron" (Ref. No. 2 above), and with regard to the diagrams of nickel-silicon cast irons, these had been taken from the author's early work at Birmingham University.*

As to the question of high-test cast iron, the author indicated that there was no special difficulty in obtaining regularly strengths in excess of 25 tons per sq. in., whilst individual results as high as 32 tons per sq. in. had been recorded.

### Influence of Vibration

MR. BEN HIRD asked if Dr. Everest had noticed that there was a considerable addition to the strength of cast iron after it had been subjected to vibration over a period, whereas steel had a tendency to tire?

DR. EVEREST said that he fully realised that nickel was an expensive element and it was quite easy to adopt the short view and to say that cast iron was not a suitable base for such

(*Concluded on page* 398.)

* "The Influence of Nickel and Silicon on an Iron-Carbon Alloy." "Journal of the Iron and Steel Institute," 1927, No. 2.

# Indian Foundry Production*

By William T. Bruce

It is common knowledge that British people have an extremely high opinion of their capabilities in the production of anything in metal mechanical, or otherwise, in cloths, etc., and are they not entitled to this opinion? Yet they forget to take into consideration the fact that foreign countries are employing many clever British engineers, designers and foundrymen for the purpose of instructing their people in the most scientific and cheapest methods of production, and in forgetting this they are lagging behind and failing to appreciate that the pupil always has a tendency to leave the teacher behind, which is something that has happened through the ages.

It is not intended to imply from this Paper anything of political significance, but it is sought to make readers realise what this country is up against, and what is required to win back her laurels in world trade. In giving this warning the author takes as his example the competition encountered by the foundry industry of India, including its methods of production there, cheapness of production, the character of the Indian workman and, moreover, the Briton who makes his living in India, works for India. His whole interest is in the success of Indian industry. He gives his best, and is delighted to know that he is relieving the old country of the production of a line of things, due to the lower price, that have been invented, proved and made in this country for many years.

### The Indian Moulder

The Indian moulder of average intelligence is a man who realises his position as a producer, and is neither ashamed of it nor at any time slow in letting his friends and acquaintances know that he is a moulder.

The social standing of an Indian who is a moulder is very high in India. In the villages he is called "Mistri," a name given to people of artistic and mechanical ability. The Mistri is a man respected in all phases of village life, as he is responsible for the making and installing of its crude mechanical things, such as winders for the village wells, irrigating buckets for lifting water from sumps to higher, dryer ground. The worthy Mistri is the maker of brass pots required for cooking, mats, and curtains in split bamboo. In fact, the Indian moulder is a man who is skilled in the making of almost everything that is essential to Indian village life, excepting medicines, cloth and clothing, and in the foundry when being taught how to mould a job is most receptive.

### The Works

The author showed two photos. Fig. 1 shows, with a black mark above it, in the top right-hand corner, the Light Castings Company, subsidiary to the parent company. The white building to the right is the foundry and machine shop, the pattern shop cannot be seen as it is a dark building lying between the smaller white building on the left of the foundry and the foundry. The company's private line stretches just at the top of the chimney on the extreme right out to the light-castings foundry and runs between the pattern shop and the foundry, and in close proximity to the cupolas, the coal, coke and pig bins being just at the right-hand side of the line and immediately behind the cupolas.

FIG. 1.—GENERAL VIEW OF A LARGE INDIAN FOUNDRY.

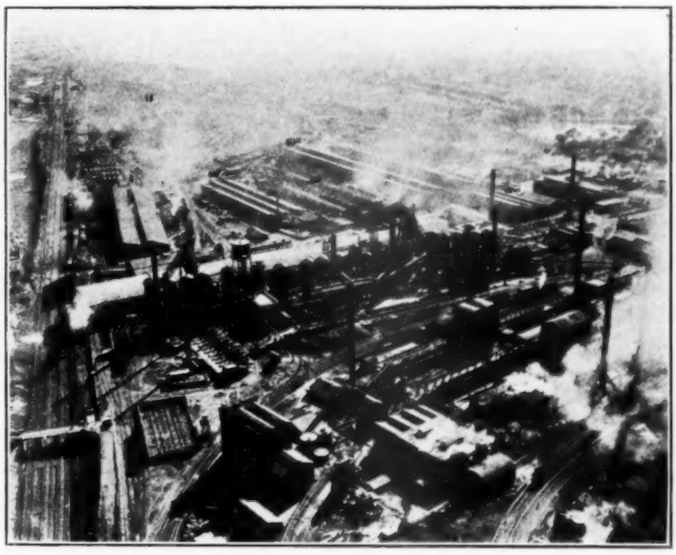

FIG. 2.—SHOWING THE INDIVIDUAL SHOPS OF THE WORKS.

In Fig. 2 is shown the No. 2 sleeper foundry (which is the main sleeper foundry) to the left with one black stroke above it. The cupolas and apparatus are to the right of the shop. In this foundry a continuous-moulding plant is operating. The large-pipe foundry is on the left at the back of Fig. 2 with two black strokes above it. Pipes up to 48 in. dia., 12 ft. long, are cast here. There is also a sleeper shop here as well. No. 1 sleeper shop is in the centre of the picture with three black marks over it. No. 2 pipe foundry is on the right of No. 1 sleeper shop with four marks over it. The cupolas can be seen at the near end. The coke and iron is all sent up by electric lift and charged by hand.

The general casting shop, on the right of No. 2 pipe foundry, with five dots above it, is a big shop and capable of producing 85 tons of finished castings a day. The shop on the right with the six dots above it is the pattern shop. Both wood and metal patterns are made here, and it is fitted out with the machinery which is essential to good and economic production.

The company has about 10 miles of railway lines running through the works—an indication of its extent.

In the general casting foundry are made vertically-cast pipes, vertically-cast pile cylinders for bridge building, pile shoes, sleepers ("plain" and "pot" design), acid pans, and fittings of all types for water, gas and sewage schemes, and a great variety of other castings.

### Vertically-Cast Pipes

Vertically-cast pipes, 3 in., 4 in., 5 in., and 6 in. dia. by 9 ft. long, are made in the general casting foundry, and these sizes and sizes up to 4 ft. dia. by 12 ft. long are made in the large-pipe foundry. The moulds are all dried with gas, and two, three and sometimes four pipes per day are got per casing in the smaller sizes.

The vertically-cast pipes are all made to British Standard specification and cast in half casings, which in the smaller pipes are hinged together, only one half being attached to the beam support by a bracket at top and bottom of the box, and on the large pipes, say over 15 in. dia., each half of the casing is supported on a rail top of beam supports on either side, with wheels affixed for easy handling. These boxes, when closed, are held together with special clamps with a snug at one end and a slot hole at the other for taking a flat tapered wedge when the clamp is fitted into the interstices in the snugs on the boxes for the purpose, the wedge being then tightened up. The plant for a box consists of the two half casings, the bottom plate (which is hinged to one half of the box in the case of pipes of 15 in. dia. and downward, and in the case of larger pipes left loose) the Kellet plate for shaping out the socket and taking the machined print on the core bar, and the core bar.

Spigot-and-socket pipes up to 4 ft. in dia. and 12 ft. long are made in these casings with a Kellet plate and core bar. The pattern is the full length of the pipe, which leaves no possibility of marks being left on the casting, which would be sure to be had with a short pattern requiring to be drawn three or four times to get the full length. (It is not insisted that it is impracticable to work a short pattern in this country, yet it is reasonably certain in India.) The casing is rammed up by two moulders and a helper, or apprentice, and they have been known to make fifteen 12-in. dia. pipes in an 8-hrs. shift.

The core bars are just pipes with an internal strengthening patch at each end which serves to take the two mandrels, the mandrel with a mild-steel round bar cast in, which has a lifting hole drilled in it, at the top end, and the mandrel at the bottom end of the core bar, with the mild-steel round bar cast in it with no

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* Abstracted from a Paper read before the Edinburgh Section of the Institute of British Foundrymen, Mr. William Wallace presiding.

lifting hole. The mandrel can be seen on the core bar in Fig. 3.

The bars are swept up at the board, as usual, 1½ in. being left all round for the loam. Straw is not used to build up the core, as is the common method in this country, but the core bar is first brushed with a wet brush, then a mixture of 5 per cent. floor sand, 45 per cent. horse manure, and 50 per cent. medium shavings, made damp with medium clay water, is pasted on to the bar with the hand (not swept on), say, ½-in. layer, and the core bar is put into the stove to dry thoroughly. It is not dried at too high a temperature, as the layer of venting and building mixture burns, an even temperature of up to 350 deg. C. being safe. The first skin dried, the core bar is set into position again in the trestles, with the board set to diameter, and the first layer of loam swept on leaving about ½ in. clear of the board for skinning the fine loam. In the case of heavy cores, over 2 ft. in dia., the bar is again put back to dry before the skinning is done, but on all the 24-in. dia. pipe cores, and downwards the core is skinned immediately.

When the core is skinned and thoroughly dry, it is brought out of the stove, carded to break away any smoothness on the skinned surface, and washed lightly with water, then blackwashed, no sleeking being done, but the blackwash being evenly washed down with the brush; then a mixture of plumbago water is washed over with a touch of liquid gum in it, to help to harden the skin, the mixture being applied with a lengthwise movement of the brush, so that the brush marks on the blackwashed surface of the core are running lengthwise, a great aid in drawing the core bar when the job is cast, and helpful in the perfect skinning of a pipe in the inside, there being no abrasing action by the metal on the blackwash when the job is being cast. No sleeking is done, because it is an expensive operation, and competition is keen. Sleeking is rather a tedious job for the Indian moulder, and takes a long time.

The operation of closing the job when dry is simple, the Kellet plate with the inside socket shape being laid into the machined service print in the bottom plate; the bottom plate is lifted from down through the casing by a cast-iron cross with an eye-hook cast into it, bolted into position, then the core put in, and held central by cast-iron wedges jammed in between the core and the mould at the dirt head, which usually ranges from 4 to 6 in. long. Four wedges are used for centring the core. The core, in the case of the pipes with socket, and spigot is not held down by any means, there being no necessity for this.

When these pipes are cast, the core bars are drawn some 10 to 20 minutes afterwards. If

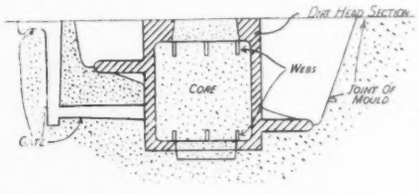


FIG. 4.—SECTION OF PILE SCREW, SHOWING METHOD OF RUNNING.

the bar be left in longer than 20 minutes, it is found to be very difficult to remove, and sometimes this cannot be done, and the job is left to be taken out by the dressers next morning, who are paid a piecework rate for the job, it being beyond their job of chipping the castings, the minimum number of men being used for cleaning and chipping.

The cost of production of these vertically-cast pipes being reasonably cheap, it is doubtful if a foundry with the spun-pipe plant could produce cheaper. This is taking into consideration the cost of the spun-pipe plant, which could be spread over a number of years as a percentage on the works' cost per ton. This point is brought in reference to production in the east, the average wage there being well below 40 per cent. of the average wage here.

### Pile Cylinders and Screws

These are made in the half-casings like the pipes, the core being rammed up in sand on an ordinary pipe-core bar in an iron corebox. As there is rather a heavy hang of sand on the core bar (due to inability to use core bars on

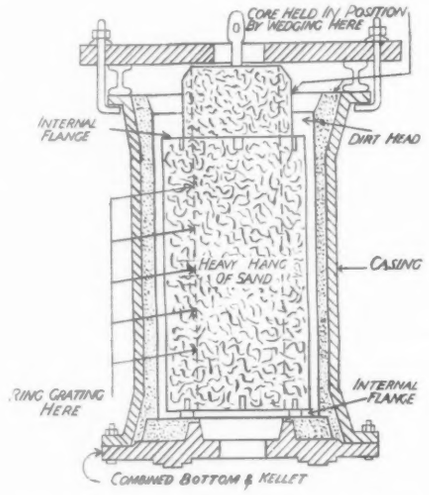


FIG. 3.—SECTION OF PILE CYLINDER MOULD. NOTE THE HEAVY HANG OF THE CORE DUE TO INTERNAL FLANGE.

these cylinders having only 2 or 3 in. allowance, and to sweep them up because of the internal end-flanges), the sand is supported by ring gratings with toes which are placed at intervals over the bar and wedged on. One of the gratings is first placed above the pattern and on the sand over the bottom flange to hold it. A 4- to 6-in. dirt head is put on these cylinders, as is shown in Fig. 3.

Four wedges are used for centring the core, which is held down by a beam, specially made for the purpose. It is rested on two stools on the edge of the box and bolted down at each end to the box. The core is then wedged up from the beam.

It has been proved that to sweep up the core of these pile cylinders with so heavy a hang takes three times longer to make than the core rammed up, and is not so sound. As many as three of these cylinders, 3 ft. dia. to 8 ft. and 9 ft. long, have been cast a day by a squad of some eight men (including coremaking), so that can be considered as an achievement. Four of the men are skilled and the other four helpers or apprentices.

The screws for these cylinders were bedded in the floor, the pattern being made full size. Wood staves were rammed into the floor with the pattern for the "drop-" and "in-gates," as is shown in Fig. 4. The smaller sizes of screws, 2 ft. 6 in. and less, are made in green sand in boxes, and a squad of 12 men with 2 women, and a coolie for riddling sand, have made as many as twelve a day of the 24 in. dia. size. Four out of the twelve men were skilled moulders, the balance were "rammer" coolies. The bottom part was rammed on a turnover board, with the joint shaped-out, so there was little time wasted in cutting and sleeking, which is normally, on a joint of this type, a tedious job.

### Sleepers: Plate and Pot Design

There are at times 4 to 6 dice of sleepers being made in the general casting shop. A dice consists of a line of sleeper moulds, numbering anything from 100 to 120. The weight of the sleeper, of which there are many designs, ranges from 90 lbs. to 115 lbs. The patterns are all plate patterns; the actual bottom-part pattern itself, with the jaws on it, being aluminium screwed on a cast-iron plate. The top-part pattern is all cast iron, screwed on an iron plate. It has cross-strengthening ribs on it, this part being the actual bottom plate of the sleeper (see Fig. 5).

In W. H. Coles' book "The Permanent Way," revised by Col. Hearn in 1928, it says that a great advantage of the cast-iron sleeper is that broken plates and pots are few, and have always the value of the metal, which can be recast. The statement is misleading, and what should have been said is, that there is always some value in the metal as scrap. The sleeper cannot be made to specification if it is cast from broken sleepers merely remelted, as the metal loses its physical properties and changes its structure in the recast.

Seven "rammer" coolies ram these pot sleepers in one dice, shown in Fig. 7 (these men are the aborigines of India and come from the Santal Pergunas). Four work on the drag and three on the top. The drag pattern with the jaw side of the sleeper may weigh as much as 150 lbs. and the top pattern 110 lbs. Thus, with the boxes clamped on after being rammed up, it is arduous for two men to turn over these by hand and rest them properly on the bed of sand prepared for them. More knack than strength is required for this job. These Sanal "rammer" coolies are men averaging 5 ft. 4 in. in height, and, at a rough guess, weigh about nine stones, and, living out in the Pergunas to-day, as their ancestors did many hundreds of years ago, makes them a very hardy race. They are fearless, very frank and open in all their dealings, and any visitor to the works is impressed by the way they work.

As at times there were two or three of the foundries engaged on making sleepers it was difficult to get these Sanal coolies who had any previous training; the trained men all being already employed, one has to take a squad of young untrained men, ranging from seventeen to twenty-five years of age, with an older man in charge of them, called a Sirdar, and who has had a good practical experience on the work of ramming moulds.

The method of showing these coolies how to ram the sleepers is as follows:—The sand for each dice, being riddled in a long line, the pattern of one sleeper is put down at the end of the line, in position "A," the top being rammed alongside the bottom part, whilst the pattern of another sleeper is put down in position "B," the top being rammed alongside the bottom part with just sufficient room between the lines "A" and "B," to allow for one top part to be rammed. The object is to save space. The

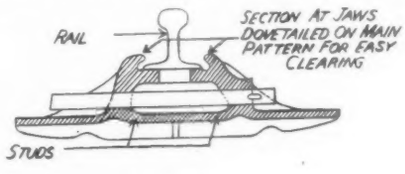


FIG. 5.—PLAIN TYPE OF SLEEPER WEIGHING 93 LBS.

foreman moulder, with the aid of the sirdar, commences making the moulds in one line himself, with the coolies looking on. The lay-out is shown in Fig. 8.

The pattern is first brushed perfectly clean, then some sieved jaw sand (mixture of 50 per cent. sand of similar quality to that of London sand plus 50 per cent. of rock sand) is sprinkled over the pattern by hand and pressed under the jaws and over them and in the corners, where there are webs reaching down from the corners at the top of the jaws to the plate, it being emphasised to the coolies looking on that particular care should be taken to see that the over-

lapping parts of the jaw, which is dovetailed on to the main pattern, are not raised above the main pattern when the jaw sand is being pressed below them.

The type of casting referred to is illustrated in Fig. 5, showing parts dovetailed on to the pattern of the sleeper. The bottom box is then laid on the pattern, being correctly centred by the pins affixed to the snugs at each end of the plate, having dog clamps attached for holding the box and the plate-pattern together, and a course of sand up to the top of the box is filled in and pin-rammed by the foreman and the sirdar, the foreman ramming one end of the box, the sirdar the other. The box has one strengthening bar across the centre. In the

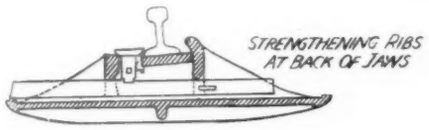


FIG. 6.—"UNIVERSAL" TYPE OF SLEEPER WEIGHING LESS THAN 90 LBS.

pin-ramming of the box, the foreman and experienced sirdar are particularly careful in ramming the first course and in ramming every course, neither overdoing the ramming, which is a waste of time, nor neglecting it, which would give an excessively heavy casting. It must be done methodically, as the character of the Sanal coolies, who are watching them, is such that every instruction will be carried out to the letter, and each operation copied exactly. The first course of sand rammed, the second course is filled up to the top level of the box again and dog-rammed, the foreman using one dog ram and sirdar the other; then the third course is filled in 4 in. above the level, dog-rammed, the box levelled off by the sirdar and vented by the foreman, the object being to instil into the "rammer"-coolies' minds that each must do his bit in turn. The job is only vented between the strengthening webs running down from each corner of the jaws to the plate of the sleeper, to take the gases away from the fillets at that part, because of the wash of metal over these fillets when the job is being cast, burning the sand, resulting in a great accumulation of gas which, if not allowed to go free, causes a bad casting.

The bed of sand is made, the box and pattern slung over on to it by the foreman and the sirdar, levelled out, *i.e.*, pulled back and forward to find a good seat so that there will be no rocking, and hence no possibility of the mould

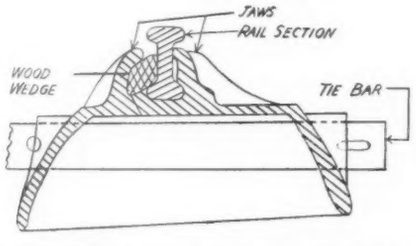


FIG. 7.—POT SLEEPERS (GRAVES' SPHEROIDAL).

being jarred when the pattern is drawn. The pattern is then rapped with a 2-in. dia. by 9-in. long iron bar by the foreman, who strikes the plate of the pattern twice on each side, once on each end, and twice at each end on top (no more and no less rapping being necessary); the sirdar knocks off the clamps, and both grasp an end of the pattern quickly, leaving a perfect imprint of the pattern on the mould, and no breakage. The foreman draws out the two sections of the jaws left in the mould carefully, and places them in the pattern again.

The four "rammer"-coolies now carry out the instructions so carefully given and the foreman then tries the mould to see that it is sufficiently firm, and if it be so just stands by to watch a few moulds made until he is quite satisfied the coolies have achieved the necessary skill. There are only two moulders on each dice of sleepers, and as there is just sufficient time for them to set the cores and make up the heads, it is quite impracticable to repair moulds made from the patterns with a perfect finish. Experience has shown perfect moulds can be made, and no repaired moulds are tolerated.

For the first week of using these patterns a little trouble is experienced due to minute crevices on the side of them tearing the face of the moulds plus that caused by breakages due to bad drawing of the pattern, but after a week or so that is quite overcome, the pattern being in constant use, and the men acquiring the necessary skill. Incidentally, if the patterns start tearing when just put in use, the coolies rub on finely-sieved "skilly" each night to rust up the crevices, and in the morning rub the patterns with a soft red brick until it is clean, then polish by hand with good plumbago. This helps greatly in making the pattern easy to draw, and leaves no tears or breakages.

### Top Parts

The top part of the sleeper is much easier to ram and handle, the box only being 4 in. deep, the pattern having the bead for stiffening round the edge, and two ribs for strength, one running lengthwise in the centre of the plate, and the other across it in the centre. The ribs are not more than 3 in. deep. Out of the three "rammer" coolies on the top part, two are specially picked for the drawing of the pattern. Two gate pins, about $1\frac{1}{4}$ dia. each, are rammed up at each end for running the job, and in-gates are made by horse-shoe gate patterns, screwed on at each end of the plate; the top is rammed hard, two courses of sand being given, the first course is pig-rammed, the second dog-rammed, the top scraped off and again dog-rammed. No venting is done before turning over the box and the pattern on to the sand bed, but when the box is turned over, and the plate patterns rammed, the bottoms of the ribs are vented with a very fine vent wire, a little under $\frac{1}{16}$ in. dia. to help to evacuate the air which accumulates in the centre of the mould when the job is being cast.

The core in the centre of the sleeper is of oil sand, and is held down by two perforated studs placed at diagonally opposite corners on top of it. Fig. 5 shows the position of the studs. It is the job of the moulder, with the assistance of the three top-part coolies, to close the mould. The top is only tried on the drag once, lifted, and the moulder ascertains that the perforated studs on the core have not started the top at the part near the ribs. If it is satisfactory, it is finally closed; if not, the top is rejected and another top used. Every available inch of space is used for the sleepers, and to carry out the system correctly, the men on each dice are instructed to close the moulds whenever they have 50 top parts ready. Fig. 8 shows the lay-out of the sleeper dices.

### Testing the Sleepers

A very rigid test is specified for the plate sleeper, the transverse test being a 2-in. by 1-in. bar placed on two centres 3 ft. apart, and having to take a 30-cwt. load and show before rupture a deflection of not less than 0.30 in.

The importance of the mould being properly rammed is obvious, as at the jaw section only $\frac{1}{32}$ in. tolerance is allowed between the keying surfaces here and the steel rail. Accuracy in shape is so important that, when the two rails of the section of the sleepers being tested are keyed up in a pair of plates and fitted with the standard tie-bar and fastenings, the rail gauge must not vary from standard $\frac{1}{16}$ in. either way. If they do, there is a chance of hundreds of sleepers being rejected. Castings less than 2 per cent. below the specified weight are not accepted, and as they are paid by weight, the weight above the specified weight, plus 3 per cent., is not paid for, but are accepted, so the founder may meet trouble in either direction. A falling-weight test is taken daily on one sleeper from each dice, the weight being $3\frac{1}{4}$ cwts. The sleeper with a small section of rail fixed in it is placed below the falling-weight machine in a bed of sea sand; one blow is struck from 3 ft. to consolidate it in the sand, then three blows at 7 ft. are struck. This test is for broad-gauge sleepers, the test for metre-gauge sleepers being

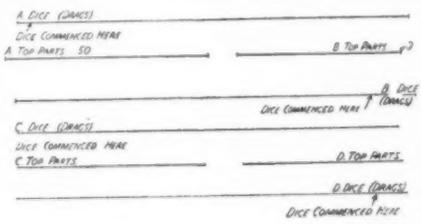


FIG. 8.—LAY-OUT OF A DICE OF SLEEPERS.

one blow at 2 ft. and three at 5 ft. The plate sleeper or the pot sleeper, as the case may be, is not allowed to be moved or reset unless it is canted from its natural position. When the sleeper has been subjected to the test, it is examined for cracks. A crack at the jaws or rail seat will rank as a fracture under the test, but if a crack shows at the tie-bar lugs or the strengthening ribs, the plate is struck another consolidating blow, and subjected to three further blows at 7 ft., and if the sleeper stands this without a further extension of the cracks, and no fracture, it is passed, whilst if it does not, it is rejected. One-half per cent. at least of the total number of sleepers cast is subjected to the falling-weight test, but anything in excess of this may be taken at the Inspector's discretion.

These details have been given to dissipate any suggestion that a plate or pot sleeper is a thing easy to make, and to emphasise that with the unskilled labour available the production of sleepers is no mean task.

### Loam Moulded Castings (Caged System)

All large straight flanged pipes, plain and with 90 deg. flanged or socketed branches, have to be made by the caged loam-mould system, that is, in vertically-cast loam moulds with the building rings intermittently spaced with holes in them

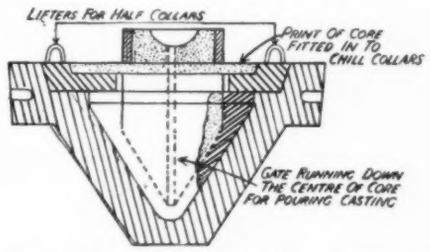
LIFTERS FOR HALF COLLARS
PRINT OF CORE FITTED IN TO CHILL COLLARS
GATE RUNNING DOWN THE CENTRE OF CORE FOR POURING CASTING

FIG. 9.—PILE SHOE CHILL MOULD, SHOWING HOW IT IS SUPPORTED ON COLLARS FOR CHILLING THE HEAVY SECTION AT THE SHOULDER OF THE SHOE.

for taking the 2-in. sq. bar 6 in. larger than the actual casting length, the bars, when the mould is built and dry, being fitted into the rings and wedge up. Initially, a little difficulty was encountered in explaining the method of making the boards for sweeping up, especially the bottom-part board, and its relationship with the board for the cope and core, but this was surmounted by sketches being drawn in chalk on the pattern-shop floor by the foreman, showing how the

boards swept and how the faces worked in. Whilst the boards were being made the necessary plant was being cast in the foundry, consisting of two bottom plates, one core plate, a cope ring, a cast-iron cross for the sweeping spindle, three building rings for the cope, and four building plates for the cores, and a shear iron. As an ordinary box was used for the top part, there was no necessity to cast a plate with fingers on it for this.

When the plant was completed the bottom plate was put down, being laid perfectly level on three 8-in. by 6-in. steel beam-section stools, which had first been placed on plates approximately 18 in. by 18 in. by 1 in. thick, bedded on solid ground, so that there would be no chance of the job sinking. The stools being set into position, the bottom plate was laid on, the cross, with the machined hole in the centre for taking the spindle, was affixed with three clamps to the three snugs in the centre of the bottom plate, and whilst fixing the board for sweeping the core-print, the face of the bottom flange, and the service print for the cope, to the shear iron already attached to the spindle. So that the bottom of the print would be perfectly level, a gauge stick and spirit level was used for the job of setting up the board. The board was attached to the shear iron by three ½-in. bolts 2½ in. long, and the shear iron had a bush at the one end with a hole in it just ⅛ in. dia. larger than the diameter of the spindle, and it was held by one stud set in the bush and tightened up. All the bricks had to be placed at least ¾ in. from the sweeping face of the board to take the coat of loam, but when they were set in position the moulders were slow to appreciate that the loam must be well rubbed on the face of the bricks at the bottom of the mould where the metal dropped, *i.e.*, the flange face, as a great heat was encountered there during casting. Where the loam was not well rubbed into the face of the bricks, pockets of air were left, resulting in the loam at these sections being spalled, due to the air in the pockets expanding rapidly.

The prints swept up on the bottom plate, the board and the spindle were drawn, and the bottom part was left to dry for a few hours to stiffen up, and whilst waiting the moulders were put on the job of laying and sweeping up another bottom plate, so that no time be wasted on the job. When the first bottom part was quite dry the men were put on to sweep up the core.

The core plate being first set (this had three 1½-in. dia. wrought-iron lifters on the snugs in the centre of it), the board was set up, the method being with the gauge stick (which had both the internal and external diameter of the pipe cut on it), the level, and the loose sprigs set in clay at the top and bottom of the board on two opposite sides for getting correct alignment. The board set correctly, they then swept up the core, after the moulders were shown how to lay the bricks and the building rings, and the method was explained, they were left to complete the core themselves, which they did even to the sweeping on of the loam. The core was completed and lifted out of the print and put in the stove to dry for a few hours before black-washing.

It may be difficult to understand how the core could be lifted so quickly after just building, but this is easily explained in the temperature in the shop, which ranged from 105 deg. to 125 deg. for eight months in the year, and when the cast came on was often 145, and due to this heat it was sometimes necessary to wet the bricks to make the loam stick. The other four months averaged 70 to 85 deg.

The core being out, the moulders commenced setting up the board for the cope, an easy matter for them after having set up the core board and checked everything carefully. The cope ring was then placed in position, a course of bricks laid, and a building ring placed on top, the method being explained whilst this was being done; they were then left to do the job themselves. They finished building the cope, and the job was satisfactory. No fault could be found with the loam on the face of the bricks, although it was examined carefully; it had been well rubbed on, so the moulders skinned it with the fine loam, left it to dry for a few hours whilst they black-washed the core and the top part, which were put back in the stove for drying, then the cope and bottom were black-washed. The cope was not removed from the bottom part. It was dried with a portable dryer, charged with half coal and coke, with the help of a small fire in the bottom of the mould. The whole job dried in a night, the cope only requiring 5 cwts. of mixed fuel to dry it.

Next morning, before drying the cope inside at the top, required a little wash of plumbago water consisting of 15 lbs. water, ½ lb. plumbago, 2 ozs. gum, as the skin had cracked a little, and being very hot no further drying was necessary. When putting in the core, the print at the bottom was stamped to prevent any leakage of metal, with a mixture of loam and oil, and the core was tested for concentrating with thickness sticks. It was found to be $\frac{1}{16}$ in. off centre, so it was lifted out and a little sea sand (fine) was sprinkled on top of the stamping at the bottom, on the side where it was thinnest, to tilt over the core. The core was put back, and found to be central.

The core being centred, a stamping was put round the joint of the cope and the edge of the core and the top part laid on. No paper was put on this stamping as there was no necessity

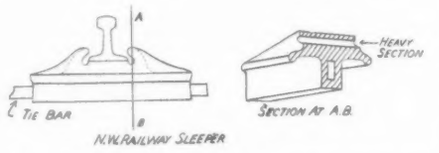


FIG. 10.—NORTH WESTERN RAILWAY TYPE OF SLEEPER, SHOWING THE POSITION OF THE JAWS IN RELATION TO THE POSITION OF THE TIE-BAR SLOT. THE SLEEPER IS ALWAYS CAST WITH THE JAWS DOWN.

to lift the top again. The top was fastened at each of the four corners with 6-in. by 4-in. beam sections, and wedges to the top building ring of the cope. Two beams were laid across the top at opposite sides and short chains were slung over these and connected up to the snugs on the bottom part, which had square clamps on them, with double-hook bolts. These were tightened up, and the job only required the head to be made. During the closing of the job, the bars had been fitted into the rings, wedged, and the space between the bars and the wall of the cope loamed up.

The head was made up. There were 8 gates and one riser, a channel being fixed behind the riser to flow some metal through at the same level as the bottom of the gates so that no metal would be left in the head. The pipe was cast without a hitch, and when taken out of the mould was a good casting. There was a 4-in. dirt head all round the top flange, and when this was cut off, the flanges machined and holes bored in it, it left a perfect surface, with no flaws. No trouble was experienced in making the balance of the pipes against the order, the men being left to do the whole job themselves, each operation being carefully controlled and checked, particular care being taken to see the moulds blackwashed correctly, as hot moulds had never been blackwashed and sleeked up before in this way, the main difficulty being the finishing up of the joints of the two blackwashed parts which met. The job required eight days, with two moulders, a helper and two Kamins (women labourers). The time on the second pipe was improved by a day, on the third by two days, and the balance were all made in six days.

### Sewage, Water, and Gas Pipe Fittings

Cast-iron bends, tees, single and double branches, tapers (socket to spigot and spigot to socket) and collars are made in great numbers in the general shop to British Standard Specification. The bends, tees, single and double branches, which are the most popular standards, are made from shell patterns up to 12 in. dia. (any dimensions over this size not being so commonly used) and are mostly bedded in the floor, this being the cheapest method of production out there, and no serious amount of plant being required for the job.

The more special sizes are made from the frame patterns with the sweep attached. On the bends, the frame is made to the shape of the outline of the job, with hollowed-out bosses, one at the centre-socket end and one at the point of the angle of the bend also hollowed out to take a spindle for the sweep for sweeping the socket. The sweep for the body of the pipe is just loose and manipulated by hand round the angle of the bend.

The sweeps for the tapers and branches, of course, are the lengthwise shape of them, and are fitted to spindles set into hollowed-out bosses at both the spigot and the socket end. The branch, or branches on the branch pipe, as the case may be, are swept out with the sweep fitted on a spindle set into the required centres crosswise on the main frame pattern.

The smaller sizes of special fittings thus made are just rammed up with sand on the bottom part, the frame being first set perfectly level on four stools. About 1 in. is left clear of the face, and then the rest is rammed up with a facing sand mixture, which is finally skinned with a loam composed of the same facing sand finely sieved. The job is left to dry for a day, and the core is made with loam and "slip" and bricks, the core iron having the necessary arm-like projections at the end for balancing them when being closed. When the core is made, it is dried a little before it is lifted out of the bottom of the mould. The top part is made exactly the same way as the bottom swept up in an iron box.

The greater diameter of these fittings are all swept up in loam, a cinder bed being first set below the bottom part. Care is taken to see that the core is well dried in the bottom part before removing it.

### Test on the Fittings

The acceptance tests for these water, gas and sewage fittings are severe, the transverse being 28 cwts. from a 2-in. by 1-in. bar at 3-ft. centres. The tensile breaking strength must be not less than 9½ tons per sq. in. In the Inspector's presence a minimum of two bars has to be broken daily, and a day's cast is at stake if they are not satisfactory, but up to six bars may be tested of both transverse and tensile type.

There are limits for deviation in weights, two examples being as follow:—On 3-in. to 7-in. dia. pipes, the tolerance is 4 per cent. above and below, and on 32-in. to 42-in. dia. pipes it is 2 per cent. above and below, and it is no easy task to keep within these.

### Pile Shoes

Shoes for cylinders and screws are made in chill moulds (see Fig. 9), in which is shown a half-sectional view of the pile shoe mould with the collars for making the shoulder and the core in position. The collars, which are together an ordinary ring, with the service print for the core in them, is made in two halves for facility in loosening the job, a fin being on every one of these shoes at position "X" when the job is cast.

The core is supported in the two half-collars. The core is made on an ordinary grating fitted into the part with the greatest diameter, where the metal of the casting is, and has long spikes in it, and one of two malleable rods cast in for lifting the point. Three lifters are cast into the top for lifting it. The pile shoe is run by one round gate down through the centre of the

core, as is shown in Fig. 9. A small part has been sectioned off to show the outline of the cross-section of the casting. These chilled moulds used to be cast with a ¼-in. allowance for machining the mould down to the pile shoe dimensions, but it was soon discovered that this was an expensive operation, costing well over £25, so the pattern of the chill mould for the pile shoes has now been made to the exact dimension of the pile shoe, and the job is cast with the very minimum allowance for ming the face of the mould, which reduces the costs by about four-fifths.

A man and a boy may make up to 16 a day of shoes weighing about 112 lbs. The cost, including coremaking, is about 9d. each.

No. 1 sleeper shop, which had been closed for about seven years, was reopened during the author's stay, and manufactured about 45 tons a day of the N.W. Railway type of sleeper, using the same methods of production as the general castings shop. The difficulty with this sleeper, the rough outline of which is shown in Fig. 10, was the heavy section at the jaw; this was cast down, drawing and leaving a hole at the gate which was on top of the tie-bar section at "X." Various types of gates at different positions were tried, but nothing was more successful than the flat gate at position "X." The important factor was the casting temperature, and, if the sleepers were poured at about 1,110 deg. C., good results were always obtained.

In No. 2 sleeper foundry some 65 tons of sleepers are cast daily, half of these being made on the continuous-moulding plant installed there, and the output was increasing daily at the time of the author's departure. A great deal of work was involved in making the patterns of the sleepers to this plant, and training the hands, but it is now proving a great asset, and as time goes on will improve its output.

The large-pipe foundry at its busiest is capable of a daily output of easily 50 tons of vertically-cast pipes, plus 40 tons of sleepers.

No. 2 pipe foundry also produces vertically-cast pipes up to 9 in. dia. by 9 ft. long; at times well over 200 good pipes daily are cast in this shop. Coremaking and moulding are on a piecework basis. Chipping and transport are also on piecework.

The Light Casting Company, a subsidiary concern, is about a mile and a-half distant, and all types of light castings are produced there, including rain-water goods, soil and ventilator goods, cisterns, electric-fan castings and even sleepers. The light-castings trade in India is very busy just now, and this shop is producing 220 tons of castings a week, including some four dice of sleepers daily.

Rain-water and S.V. fittings were made from shell patterns, the more popular standards being made from plate patterns with suitable core-boxes. The popular standards are usually made on jolt-ram machines from plate patterns.

### Gating 4-in. Pipes

The rain-water, S.V. and S.S. pipe moulds are all, up to 4 in. dia., made two in a box, on stripping-plate-pattern machines. The pipes are not run with flat drop-gates on the top of each pipe as appears to be the popular method in Britain, but four round drop-gates are placed in the centre of the two patterns and on the top of patterns of inlet gates. The inlet-gate patterns are well tapered, and when the pattern is dropped on the stripping plate, and the bottom part of the moulding box lifted and turned over on to the pit, the gate patterns fall out themselves, being left lying on the stripping plate.

One great advantage of the inlet gate on these pipes is that they have very little excess metal for chipping, but on the pipes with the drop-gates on them, many companies, finding it too expensive to chip off the fillet part at the gate, leave it on, resulting in an ugly mark being left on the job, and with a company's trade mark on the pipe it is a poor advertisement. Architects who are responsible for the buildings may not say anything when they get ugly fittings for a job, but they nearly always find out who supplied them and suggest that another firm be tried the next time.

On the 6-ft. pipe moulds, with the pipes up to 4 in. dia., four "rammer" coolies ram 40 boxes per day, and are paid at the rate of a rupee each per day. The time of one moulder is divided on three dice of the pipes; with 40 boxes to the dice his rate comes out at about 8 annas per 40 boxes, plus 9 annas for one boy for "slipping up" and clamping up on each dice. Then there are two emptiers for taking the pipes out of the boxes, stacking them up at one end of the dice, knocking out the boxes and stacking them at the other end near the pattern; they are paid a rupee each per dice. They do one dice only, so that is a rupee a day each man. Then there is the cost of coremaking on the job; the cores are all made with semi-skilled labour, there being some seven men and the coremaking Mistri on the making of some 800 cores per day on two impact-ramming machines.

### Cisterns

Cisterns are all made from plate patterns. The core and bottom part are made on the one pattern together, then the mid part is made on a separate pattern, and so also is the top part. It is cast with the bottom up, being poured by two round gates, one on each end. The gates are about ¾ in. dia. The cover of the cistern is made on a two-sided plate pattern, so also are the chain lever and the bell lever. The bell is made from an ordinary pattern, there being two, and the bottom parts are rammed up on a turn-over board, two "rammer coolies" and one moulder being employed.

The stand-pipe moulds are made on a single-sided plate pattern, four patterns being on the plate. They are screwed in the machine shop at a piecework rate. The number of men making a dice of cistern bodies per day, which is some 55 moulds, is eight; six of them are rammer coolies, one moulder and one boy. They are paid a certain rate of 48 satisfactory castings per day, a premium over this number being paid and less being paid proportionately less.

### Shop Conditions

Shop conditions are very good, as they are built with the sides left open for perfect ventilation. The roofs are all asbestos plates, the top of the sides being glass, and the lower parts corrugated-iron sheeting. At times there are very high winds out there, and in the case of the light-castings shop, the lower sides of the shop have shutters fitted on hinges so that they can be lifted on hot, dry and calm days for ventilation and lowered when the high winds are blowing a great deal of dust about, light-casting moulds being easily spoilt by light dust and producing positively bad castings. The windows of the shops are kept perfectly clean and the interiors are from time to time whitewashed and painted as necessity demands, and every effort is made to keep the shops adequately lighted.

### Cheapness of Production

Cheapness of production is the result of cheapness of living rice, milk, nuts and fruits and vegetables of all kinds being extremely cheap, and constitute the Hindu moulders' and coolies' main diet. The Mohammedan moulder is, of course, a meat eater, but is particularly careful about having diet well balanced with vegetables.

Clothes are also cheap, the men's garments consisting of a thin cotton shirt and dothi, or skirt, which is a piece of 3-ft. or 4-ft. board bottom cloth, or Indian handspun cloth, ranging from 5 ft. to 8 ft. long, wound round their waist, tucked in at one end. The whole outfit never costs them more than five rupees.

The better type of moulder and the sirdars all wear shoes, which cost from two rupees to four rupees, and at four rupees are considered pretty expensive by the men. Most of the men discard their shoes during the working hours.

Although companies in this country could never, with the high rate of wages paid, due to the high cost of living, give their workers free quarters for living in, this is one advantage the Indian workmen in the services of the company have over there. The quarters are cleaned regularly by the company's own sweepers. A thorough inspection of the quarters is made at different times to see that their conditions are sanitary, and they are whitewashed from time to time and repaired immediately they are defective. It is the job of the Zemindary manager to see that the traders in the company's village do not charge exorbitant prices for goods; thus everything possible is done for the welfare of the Indian workman.

## Catalogues Received

**High-Duty Cast Iron.** One of the smartest pieces of publicity ever emanating from the foundry industry has been assembled by Ealing Park Foundry, Limited, of Junction Road, South Ealing, London, W.5. It deals with the products of the Meehanite Process, of which they are licensees. If there be a fault at all, it is to refer to processes A, B, C, etc., before they have been explained. There is, however, a minor mistake, and that is the retention of certain Americanisms, due to the fact that the process, which involves innoculation, was developed in the United States, mainly, by that erudite British metallurgist, Oliver Smalley. Thus we find the word "draw" creeping in instead of "temper," whilst Fahrenheit degrees are used where Centigrade would be preferable. It is, of course, obvious, that the Bulletins of the Meehanite Research Institute are frankly American, but their worth is undoubted, and if the American results can be repeated—as we believe they can be under European conditions—then the prospects of the success of the Meehanite Process are indeed distinctly noteworthy. The service performances of Meehanite dies, as set out in Bulletin 3, would give the average Sheffield tool steelworks very furiously to think, to use a rather trite expression. Of course, this catalogue is not meant for foundrymen, but we are reasonably sure that the direction of Ealing Park Foundry is so broadminded that they will send it along to any of our readers.

**Sand-Testing Apparatus.** For the first time in history there is now available a leaflet, illustrating and describing the majority of apparatus available for the control of moulding sands. Amongst the tests missing are the "needle" hardness tester and elutriation apparatus, but alternative apparatus is offered. The leaflet has been issued by Ridsdale & Company, 3, Wilson Street, Middlesbrough, Yorks. The choice of apparatus tested has been largely governed by the recommendations of the Technical Sub-Committee for Sands and Refractories of the Institute of British Foundrymen, over which Mr. Ridsdale presided with such distinction until his recent resignation, prompted no doubt by his determination to put into practice, that which he and his committee had been preaching. Each piece of apparatus is described and usually illustrated. Amongst them we noted a new model—the Dawson-Hanks moisture tester, based on electrical consideration. This, however, is not yet on the market, but the technicians of the industry will welcome a description of it when the time is ripe. We urge all our readers, both at home and abroad, to procure a copy for personal use.

MR. G. ETHELBERT WOLSTENHOLME, a director of Messrs. Thos. Firth & John Brown, Limited, addressed the Yorkshire Branch of the Institution of Mechanical Engineers in Sheffield recently. Mr. Wolstenholme's subject was "A Survey of Engineering and Metallurgical Progress."

XUM

# Low-Pressure Oil-Burner Design

D. G. Young

Of recent years, the use of oil fuel for all purposes, amongst them metallurgical work, has grown so rapidly that to-day the would-be user of oil has a bewildering number of oil burners from which to choose. For metallurgical furnaces the favourite is without doubt the low-pressure type. With medium or high pressures the cost of compressors and the extra power required for their operation is a disadvantage. Low-pressure burners are usually understood to mean those working with an air-blast pressure of from ¾-in. to 2-in. mercury column, generally derived from a fan. The following remarks refer particularly to problems dealing with crucible furnaces.

### Ideal Combustion

In order to find the ideal conditions for combustion, it is necessary to consider the transference of heat from the combustion space to the crucible walls. In a crucible furnace, the pot is usually surrounded by a circular wall of highly refractory material, the space between forming the combustion chamber. Heat is transferred almost entirely by radiation, from the flame which encircles the crucible and from the walls of the furnace which become heated to a high temperature.

As the quantity of heat radiated is proportional to the fourth power of the temperature difference, it will be obvious that a slight increase in flame temperature means a large increase in heat transfer. Moreover, a high temperature flame is of necessity short, due to the increase in the rate of reaction between the oil and oxygen. This produces a high temperature in the right place, *i.e.*, round the base of the crucible. In a crucible furnace this condition is essential for efficient melting.

With a short high-temperature flame, it is also easier to obtain complete combustion before the waste-gas outlet is reached. The amount of heat carried away by the flue gas is therefore reduced to a minimum. The following dry flue gas analyses were recently obtained by the writer from a crucible furnace:—

| $CO_2$ | CO | $O_2$ | $N_2$ |
|---|---|---|---|
| 14.2 | 0.0 | 0.5 | 85.3 |
| 14.5 | 0.0 | 0.6 | 84.9 |
| 14.6 | 0.8 | 0.0 | 84.6 |
| 14.0 | 0.4 | 0.0 | 85.6 |
| 14.2 | 0.8 | 0.0 | 85.0 |

### Carbon Deposits

In the restricted combustion space of a crucible furnace, carbon deposits are sometimes troublesome. These are occasionally experienced with low-pressure burners, due to the difficulty of designing an efficient method for atomising the oil with low-pressure air (say, 1½-in. mercury column air pressure), and for mixing the air and oil droplets intimately together.

The carbon, which forms on the furnace wall where the flame impinges, is, of course, due to the deposition of unburned oil and its subsequent cracking, brought about by sudden contact with the hot wall. Hence, again, the importance of producing a short flame which will ensure complete combustion, or at least vaporisation of the oil before meeting an obstruction.

Free carbon in the waste gases is sometimes met with when the furnace is cold, but with a really well-designed burner it is hard to make a furnace smoke, and incomplete combustion is then indicated by a carbon-monoxide flame at the outlet. Free carbon is probably due to preferential combustion of the hydrogen of the hydrocarbons of which the oil is composed. If atomisation of the oil and mixture of the air and oil are both good, the free carbon is incompletely burnt to CO, and no free carbon is observed in the flue gases.

### Air Pressures

Air pressures for most low-pressure burners vary from ¾-in. mercury column to 2 in., but a normal figure is 1½ in. A fan supplying two burners burning 16 galls. of oil per hour at a pressure of 2 in. would be more expensive to buy than one which does the same work at 1½ in., and it is quite possible to obtain efficient atomisation at 1½ in. or even less.

### Burner Design

*Atomisation.*—In low-pressure burners, atomisation is almost invariably effected by the energy of all, or part of, the air stream. Pressure atomisation, by putting the oil under pressure and forcing it through fine orifices, or steam atomisation, is uncommon in low-pressure burners, chiefly due to inconvenience and extra running costs.

Much ingenuity has been expended in designing methods for atomising the oil, but very often the simpler types are the most effective:—(*a*) Oil atomised by a high-velocity stream of air surrounding the oil nozzle, which may either be controlled by a needle or mushroom-type valve; (*b*) oil atomised by a rotating stream of air formed by passing the air through helical vanes, thus forming a wide angle jet by centrifugal force and consequently a short flame; (*c*) rotating air streams forming a vortex round the oil nozzle by means of a constriction in the air pipe, thus, it is claimed, partially vaporising and atomising the oil by a reduction in pressure and an increase in velocity; (*d*) the sudden expansion of a rotating primary air stream into a rotating secondary air stream; and (*e*) burners which depend on moving parts for atomising the oil, *i.e.*, a fan which drives some atomising device, are occasionally met with, but moving parts introduce a danger of mechanical wear and are therefore not so reliable.

### Mixture of Air and Oil

From the point of view of rapid combustion and carbon deposition, the intimacy with which air and oil are mixed is almost more important than the degree of atomisation. In burners which rely upon 100 per cent. of the air passing through the burner for atomising the oil, the question does not arise, of course, but where secondary air is passed through the burner to supplement the primary or atomising air for the completion of combustion, the question is of great importance.

The secondary air may be rotated by vanes to increase the relative motion between the two streams, the oil-air mixture may be rotated to throw the oil droplets outwards by centrifugal force, or the secondary air may be made to meet the primary air at right-angles. In some systems the air supply from the low-pressure blower is supplemented by atmospheric air induced into the furnace by the high-velocity jet from the burner. Thus, the space between the blast inlet and burner must be left open.

This system has its advantages, particularly in the case of tilting crucible furnaces, where it is not always easy to arrange for the burner to tilt with the furnace. The tertiary air induced into the furnace also economises blower power to a certain extent. Apart, however, from the practical difficulties of a closed-burner system, which are often the deciding factors in the choice of burners, the writer considers that the slight saving in output from the blower is more than offset by the reduced efficiency of combustion, produced by a sleeve of cold air surrounding the flame. The introduction of any air which is not intimately mixed with the oil droplets conduces to carbon deposits and the reduction of flame temperature.

Most burners which use primary and secondary air incorporate some device for controlling the ratio of primary to secondary air. Thus, by shutting off part or all of the secondary air, a larger volume of air at higher velocity is available for atomisation and the flame is consequently shortened. If metal has to be maintained in the molten state at a given temperature in a furnace, it is better to reduce the rate of oil firing by shutting off the secondary air, rather than reducing the air pressure and the total amount of air passing through the burner. Thus, by not decreasing the pressure of the primary air, the efficiency of atomisation and hence of combustion is not impaired.

### Combustion Space

The volume of combustion space is best found experimentally for any particular furnace. The combustion space must not be excessively large or oil consumption will be increased with no corresponding increase in melting capacity. It is usual to fire into the combustion space through a pre-combustion chamber or injector box. The function of this is to maintain the temperature of the burning gases during the initial stages of combustion, so that the maximum temperature may be reached before the crucible can chill the gases and retard the reactions taking place.

### Summary

In summarising, it may be said that efficient melting depends on attaining the maximum temperature possible, and this can best be obtained by well pulverising the oil and mixing all the air passing through the burner intimately with it.

## Publication Received

**River Tyne.** Official Handbook. Third Edition. Published by Andrew Reid & Company, Limited, Strawberry House, Newcastle-upon-Tyne.

This is a very pleasingly-presented book—well illustrated and running to about 150 pages—yet somehow or other it has just "missed the boat." It can be presumed that the object is to induce people to ship their goods from the Tyne. Probably the best means to ensure this is to put forward arguments for concerns to open up new businesses on its banks. Then the trade would be automatic. We have reviewed many kinds of books of this character, but many of the others were so written that they made a direct and strong appeal to a man considering the erection of a new factory favourably to consider the district dealt with. In this book, the outlook is too egotistical, in as much as it sets out the facilities afforded by the Tyne quite logically, but from the aspect of the Tyne looking out upon the world, rather than from the point of view of the world wishing to know something of the activity of the Tyne. We know but little of the commercial activities of Tyneside, but if an examination were made of its "imports" from the Midlands and the rest of England, it would be found that sufficient malleable castings came into the district to warrant the establishment of such an enterprise. Further examination would show that vitreous enamelling was not widely practised. Yet good arguments could be put forth for the creation of such enterprises. There must be a serious consumption of light castings in the area, with its two-and-a-half-million population. Yet the supply is left to Falkirk and the Midlands, notwithstanding that Cleveland iron and Durham coke are easily available. We regret that we have had adversely to criticise the book, but we felt that it was devoid of "kick," "ginger" and "pep," to use a series of American vulgarisms.

XUM

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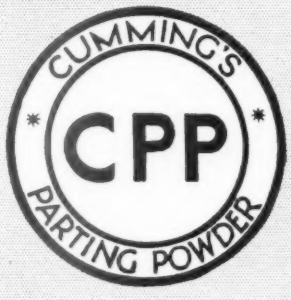


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## Scrap Metal Difficulties

By "ONLOOKER."

The present year will probably be regarded as one of the most difficult periods ever experienced by merchants, dealers and consumers, and at the moment things look more like getting worse than improving. To begin with, supplies are scarce, not so much because the scrap is not there or is not being made in the processes of manufacture and replacement, as because the quotations of new metals are so very low that on the face of it there appears to be plenty of justification for holders to keep their metal in stock rather than part with it at prices which may well prove to be in a few months' time well below the ruling market value.

As far as copper and brass scrap are concerned there is no doubt that the rumours current in regard to forthcoming world curtailment of the red metal, and the fact that in America output has already been cut down, are operating to promote a flow of optimism as to the likelihood of better prices in the near future. These hopes are based on a somewhat slender foundation, for much water will run under the bridge before the copper producers are able to compose their differences sufficiently to come together in an agreement likely to stand the test of time—and a higher price level! In any case, the scrap community can hardly hope that their prices will advance by the full improvement in new metal values, for at the present time consumers are complaining that the margins between old metals and new are inadequate. The upshot, however, of this better sentiment is the development of a hoarding tendency, which is creating a stock of unsold scrap in the country and making it very difficult for merchants and others to transact business. The railway companies, who always have a fairly large tonnage of copper to dispose of annually, do not seem to be very keen sellers to-day, and it is reported that recently they withdrew material for the purchase of which tenders had been invited. This seems to suggest that a better price is expected in the not far distant future, and since copper scrap is not very costly to finance, a "wait and see" attitude seems to be almost justifiable.

One of the effects of the holdback of scrap supplies has been the appearance of parcels of doubtful quality, and at the moment consumers are experiencing rather more than the usual run of trouble in consignments of old metal. In this bad patch American material has participated, and although, owing to the fact that the domestic price of copper in the States rules well above the export quotation, the tonnage of old metal crossing the Atlantic is not large, foundries have been obliged to voice complaints frequently on account of the presence of tramp iron. This is not a very happy state of affairs, but in view of the discrepancy between the home and export price for copper in New York, one can understand it, for obviously a better profit can be made on scrap sold in America than on material exported. As far as this country is concerned, it can be stated definitely that supplies of scrap throughout the present year have been short of requirements, and at the moment the position looks like getting worse rather than better. Many consumers have perforce been compelled to turn to virgin metals, and the scarcity of brass scrap has aggravated the difficulties of the spelter situation. Unquestionably, a higher price level for both copper and spelter would ease matters in scrap and facilitate the flow of material which is badly needed by manufacturers whose works are busily occupied.

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MR. WILLIAM KIRKHAM has been appointed manager of Messrs. Edward Wood & Company, Limited, Ocean Ironworks, Trafford Park, to succeed the late Mr. G. W. N. Nicholls. Mr. Kirkham has been with the company for many years.

## Refractories Research

### FORMAL INAUGURATION OF MELLOR LABORATORIES

At the invitation of the British Refractories Research Association a party of technical experts, representative of all users of refractory materials, were entertained to lunch at the North Stafford Hotel, Stoke-on-Trent, recently, on the occasion of the formal inauguration of the Mellor Laboratories. Lt.-Col. C. W. Thomas (Chairman of the Association) presided, and in the course of some remarks pointed out that, under the direction of Dr. J. W. Mellor the Association had carried out its investigation work, since its inception in 1920, on the grounds of the North Staffordshire Technical College until this year with the aid of grants from the Department of Scientific and Industrial Research. Through pressure of work, however, the Association had to acquire more commodious premises and a new laboratory, capable of satisfying present requirements and with room for extension in the future, had been established.

Continuing, the speaker said that the Association had been pleased to call the new buildings the Mellor Laboratories, as a tribute to the outstanding and painstaking work of their director, whose scheme for investigating refractories had really been in effect from as far back as 1909, when work was commenced under the auspices of the Refractories Committee of the Institution of Gas Engineers. Later (in 1920) the British Refractories Research Association was formed. The speaker also pointed out that they were now well fitted to carry out all kinds of investigations pertaining to refractories, but if the work was to go on without interruption it was essential to have additional financial support, and he appealed to all interested parties to give whatever assistance lay in their power. Without the necessary finance it would be impossible to progress at a rate compatible with the importance of the work, and it behoved everyone to make an urgent response.

SIR KENNETH LEE supported the appeal and emphasised the advantages which would accrue to industry if the necessary assistance was forthcoming without delay.

After luncheon, visitors were shown over the laboratories by Dr. Mellor and the assistant director of research, Mr. A. T. Green, and various members of the staff. The equipment, lay-out and organisation are of the highest order and some of the apparatus, which has been designed by the staff, is very ingenious. It is to be hoped that the appeal will receive the response that it merits and that the very extensive programme of work in hand will be permitted to proceed as rapidly as possible.

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### Leipzig Spring Fair, 1935

The Leipzig Spring Fair, 1935, will be held from Sunday, March 3, till Sunday, March 10. The Samples Fair closes Saturday, March 9, noon, whilst the Engineering and Building Fair will be open till the evening of March 10.

### Coke for Foundry Use

Discussing the effect of coking time on the properties of the coke and its suitability for foundry use, E. HOMBORG, in the "Archiv für das Eisenhüttenwesen," points out that for use in cupolas and blast furnaces the coke must be strong and hard, but not brittle. This kind of coke is fine-grained, and the pores are small and can readily be obtained in wide coke ovens by prolonging the coking time and reducing the maximum coking temperature. Although coke produced in this way undergoes crystal growth and further graphitisation in the melting furnace, it is relatively free from fissures into which the molten iron and slag can penetrate. It does not crumble, therefore, as the burden passes down the furnace; in addition it has a higher reactivity due to its regular fine-grained structure, and thus accelerates the melting process.

## Book Reviews

**Engineering Radiography.** By V. E. PULLIN, C.B.E.—London: G. Bell & Sons, Limited, York House, Portugal Street, W.C.2. (Price 45s. net.)

This well-produced and profusely-illustrated book makes no attempt to discuss the physics of X-rays or the construction and use of the various apparatus which have been specifically evolved for the engineering radiologist. The author has dealt with a restricted field, viz., the interpretation of radiographs obtained in common engineering practice. It is written with direct reference to practical problems, and thus fills a much-felt gap in the literature of engineering radiography. The examination of castings is well known to rank among the more complex and difficult problems confronting the radiographer, as there are a host of irregularities and flaws in castings which leave their record on the photographic plate but are none the less extremely difficult to interpret. To bring out these difficulties and how to overcome them, Dr. Pullin describes the investigation of sixteen special castings (bosses on vertical and horizontal plates, right-angle webs, pipe flanges and engine columns) and a series of welds between plates, shafts and pipes. The whole technique is carefully considered and the radiographs illustrating the text are of a very high standard which bring out most clearly every detail to which attention must be given. The author presents a convincing practical argument of the utility and value of radiography in engineering practice, and this work cannot but prove most useful to any investigator engaged in this work. In addition, Dr. Pullin includes a chapter on radiographic technique which deals with the always difficult question of exposure time and gives curves from which the correct exposures for any given voltage and any thickness of steel may be read off directly. These curves are naturally applicable only to one set of equipment, but they indicate how a set of exposure curves can be drawn and employed for any other apparatus. The latest development in this application of radiography is the use of gamma-ray photography, using radium as a ray source. The great advantage of this method lies in the greater penetrating power of gamma rays as compared with X-rays and the smaller amount of scattering obtained. Dr. Pullin reproduces some fine photographs obtained with castings up to 8 in. thick, as compared with the maximum thickness of $2\frac{1}{2}$ in. photographed with X-rays. The gamma-ray method should nevertheless be regarded as supplementary to the X-ray method rather than as a substitute for it.

Dr. Pullin is to be congratulated on the compilation of this work, which is constrained in tone and does not lose sight of the practical aspects of the subject from the first page to the last. This book will become a standard addition to every metallurgical library and we recommend all foundrymen to dip into it not once nor twice, but as often as possible. The only fault we have to find with the book is its price, but this is probably determined by the high cost of production, especially in the reproduction of the excellent radiographs. E. R. F.

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MR. J. E. HURST, technical adviser to the Sheepbridge Stokes Centrifugal Castings Company, Limited, gave a Paper before the members of the Sheffield Society of Engineers and Metallurgists, at the Mappin Hall, Sheffield University, recently. Prof. F. C. Lea presided. At the annual meeting of the Society the following officers were elected:—President (for two years), Mr. A. J. Grant; Vice-Presidents, Messrs. P. B. Henshaw and F. Wardrobe (re-elected), David Flather, A. Roebuck and Prof. J. H. Andrew; members of the Council, Dr. P. Longmuir and Messrs. Ambrose Firth, Edward W. Senior and G. Stanfield; treasurer, Mr. F. K. Knowles; secretary, Mr. E. J. Thackeray; auditors, Messrs. F. Wardrobe and H. Etchells.

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# This Week's News in Brief

## Trade Talk

THE TOWN COUNCIL of Turriff, Aberdeenshire, have ordered a Drysdale trailer pump and various fire-fighting appliances.

AN ORDER for a 10,000-ton twin-screw cargo liner and the resumption of work on a large tanker will provide employment for a large number of men at the Greenock Dockyard Company's yard in the near future.

MESSRS. THOMSON & STEWART launched from their Buckie yard a motorboat which had been built to the order of Messrs. Duggie Bros., of Nairn. The vessel, named the "Narinia," will be fitted with Crossley-Diesel engines, and will be employed for seine-net and herring fishing.

AT THE INSTANCE of the Glasgow Trades Council, the Corporation of Glasgow have modified the proposals of the Transport Committee for the placing of orders for 110 new 'buses, so that the whole of the steel bodies will be given to a local firm instead of 50 as originally proposed. The cost will be increased by £4,000.

THE L.N.E.R. COMPANY have placed an order with Messrs. A. & J. Inglis, Limited, Glasgow, for the construction of a Diesel-electric paddle ship, to be ready for commissioning in time for the summer service on the Clyde. Diesel-electric power is a comparatively new innovation for paddle ships, and is attracting considerable attention.

THE EMPLOYEES of the following firms have subscribed to infirmaries and other West of Scotland charitable institutions during the year the undermentioned sums:—Sir William Arrol & Company, Limited, Parkhead Works, £133; Dalmarnock Works, £230; the United Collieries, Limited, £2,372; Albion Motors, Limited, £600.

MESSRS. JOHN BROWN & COMPANY, LIMITED, Clydebank, are to construct the machinery for H.M.S. cruiser "Birmingham," which is to be built at the Admiralty yard, Davenport. The machinery consists of turbines with an aggregate h.p. of 72,000. In 1935 Messrs. Brown will have under construction turbines aggregating 500,000 s.h.p.

AN ORDER FOR 40,000 GRATES has been booked by Messrs. Allan Ure & Company, Springbank Foundry, Keppochhill Road, Glasgow, from the Leeds Corporation Housing Committee. This is one of the biggest contracts of its kind placed in recent years. An official of the firm stated that their large output capacity would enable them to complete the order very quickly.

MR. DAVID KIRKWOOD announced at a conference of workers and delegates at Clydebank that nothing can prevent the closing of Messrs. Beardmore's Dalmuir Marine Engineering Works. There was, however, a hint that a new industry might be started and the assurance of Mr. W. H. Rincke that the Diesel-engine side of the Dalmuir works would not be affected.

THE STANTON IRONWORKS COMPANY, LIMITED, near Nottingham, have taken up the production of high-manganese pig-iron, and have appointed as sole selling agents of this iron Messrs. R. G. Stone & Company, of London. The Stanton Company are proceeding to produce this iron at their Stanton works, as also at the works of the Wellingborough Iron Company, Limited, Wellingborough.

THE ANNUAL SOCIAL MEETING and dance of the directors and employees of Messrs. Jackson, Elphick & Company, Limited, Larkhill, was held on December 7, in the Masonic Hall, and proved to be the usual success. The guests were welcomed on behalf of the firm by Mr. Jackson, and among the directors present were Mr. and Mrs. John M. Jackson, Mr. and Mrs. James Jackson and Mr. Paterson.

MESSRS. WILLIAM DENNY BROS. & COMPANY, LIMITED, Leven Shipyard, Dumbarton, have received an order from the Booth Steamship Company, Limited, Liverpool, for the building of a single-screw cargo steamer, 400 ft. in length, with limited passenger accommodation. The machinery will be of the single-reduction geared-turbine type, supplied with steam from Howden-Johnston boilers.

MESSRS. LITHGOWS, LIMITED, Port Glasgow, have received an order from the United Steam Navigation Company, Limited (Campbell Bros. & Company), Newcastle, for a steamer of 8,000 tons deadweight, to be used for their ore-carrying trade. The propelling machinery will be supplied by Messrs. North Eastern Marine Engineering Company, Limited, Wallsend. Messrs. Lithgows now have about a dozen ships building or on order.

LAST FRIDAY, the London establishment of the British Oxygen Company, Limited, held their annual staff dinner and dance at the Café Royal, Regent Street, London. Dr. J. D. Pollock, the chairman of the company, presided. Speeches were reduced to a minimum, so that the staff could have as long as possible for the social side. A very enjoyable evening was passed, due in a large measure to the brilliant work of the organising committee.

THE CENTRIFUGAL PIPE-MAKING PLANT of Messrs. Cochranes (Middlesbrough) Foundry, Limited, at Middlesbrough-on-Tees, has during the past few years been engaged on making spun-iron pipes under licence of the patented Mairy process. Due largely to the increasing demand for the company's products for export, it has been decided to put down a new plant, which will embrace six further centrifugal machines, and which will be operated under the same patented process. It is hoped to have these extensions completed within six months.

BY AN EXCHANGE OF SHARES, Messrs. General Refractories, Limited, Sheffield, have acquired a controlling interest in the Meltham Silica Firebrick Company, Limited, Huddersfield. The Meltham Silica Firebrick Company, Limited, was founded in 1900 by Mr. W. J. Gardner, and was converted into a limited company in 1909. It is intended that the works shall be extended for the manufacture of super-silica bricks for the most intense heats of open-hearth steel furnaces. It is understood that the company has over £50,000 worth of orders in hand.

SPEAKING BEFORE the Free State Prices Commission in Dublin, Mr. David Frame, joint managing director of the Hammond Lane Foundry, said that at the moment his firm was able to deal with all the order for ranges, grates, mantels, etc., and in the future there would be an accumulative increase at the rate of 5 per cent. per month in consequence of foundry extensions. During a portion of 1931 and 1932 Dublin was a dumping ground for many kinds of metal work. At the moment there was a great deal of difficulty in getting moulders, but progress was being made, and there had been an increase of profits last year and another up to the present time. The Hammond Lane Foundry had never paid less than 12 per cent., and last year the dividend was 13⅓ per cent. About 80 per cent. of their business was done in Dublin.

## Contracts Open

**Cairo,** January 12.—Twelve electric pumping units and accessories, for the Egyptian Ministry of Public Works. The Department of Overseas Trade. (Reference G.Y. 14.573.)

**Standish-with-Langtree,** December 22.—(*a*) 12-in. cast-iron pipes and specials; (*b*) sluice valves, hydrants, air valves, casings, etc., for the Urban District Council. The Surveyor, Council Offices, Standish.

**London, E.C.,** December 20.—One cast-iron wash water tank, 72 ft. by 32 ft. by 11 ft. 3 in. deep, for the Metropolitan Water Board. The Chief Engineer, offices of the Board (Room 155), 173, Rosebery Avenue, London, E.C.1.

**London,** January 1.—(3) Tyres and rolled-steel wheel centres; (4) steel axles and forgings; (5) iron bars and plates; (6) steel plates and sheets; (7) steel bars and blooms; (8) steel castings (wheel centres); (9) ditto (miscellaneous); (11) chain; (12) tubes and fittings (gas, steam, electric conduit, etc.); (13) weldless-steel tubes (steam and H.P. gas, boiler, etc.); (14) iron castings, pipes, etc.; (15) galvanised sheets, for the G.W.R. The Stores Superintendent, Swindon.

## Company Reports

**Crittall Manufacturing Company, Limited.**—Profit, £177,094; brought in, £2,341; interest on loans, debenture stock and notes and directors' fees, £98,079; carried forward, £81,356.

**Thos. W. Ward, Limited.**—The directors announce that a further six months' dividend will be paid on, the second preference and employees' share capital of the company, bringing the dividend payments up to June 30, 1933.

## Personal

MR. J. E. HURST, Vice-President of the Institute of British Foundrymen, has changed his address to Ashleigh, Trent Valley Road, Lichfield, Staffs.

COLONEL C. F. HITCHINS, of Messrs. Hitchins, Jervis & Partners, consulting engineers, Westminster, has joined the board of the Partington Steel & Iron Company, Limited.

MR. BEN WALMSLEY has entered into an arrangement with the Ford Motor Company, Limited, to act as their adviser in connection with their sales of pig-iron. The Ford blast furnace, after a very successful run on basic iron, is now being changed over to foundry. During that change, several grades of special low-silicon foundry iron will be produced.

THE SCOTTISH EMPLOYERS' COUNCIL for the Clay Industries met recently to honour Mr. William Douglas, of the Douglas Firebrick Company, Limited, who is retiring after three years' service as President of the Council. Mr. James Rule, who presented Mr. Douglas on behalf of the Council with a writing desk and bookcase, said it was wonderful to think that they had a retiring President who was 81 years of age. Mr. Douglas had started work at the age of 13, and had a record of 65 years' association with the firebrick trade.

AT THE END OF THE YEAR, Mr. John I. Russell will retire, after 45 years' service with Messrs. L. Sterne & Company, Limited, Crown Iron Works, Glasgow. Mr. Russell has served the firm in various capacities, and now retires from the position of spring-shop departmental manager. He served his apprenticeship with Messrs. Blakie Bros., Footdee Iron Works, Aberdeen, and received his technical education at Robert Gordon College, Aberdeen, and the Heriot Watt College, Edinburgh. Mr. Russell joined the firm of Messrs. Sterne, Limited, just as they were starting the manufacture of refrigerating machines, and was appointed to supervise the erection of ice-making machines.

### Wills

DAVIS, F. W., of Darlington, for 35 years director and engineer of the Cleveland Bridge & Engineering Company, Limited ... ... ... ... ... £58,589

SPENCER, W. S. C., of Sheffield, a director of Messrs. Walter Spencer & Company, Limited, steel and tool manufacturers ... ... ... ... ... £1,340

HOPKINSON, A. H., for some years a director of Messrs. Hopkinsons, Limited, valve makers, Britannia Works, Huddersfield ... ... ... ... ... £254,148

## Obituary

MR. ALFRED DAVEY BEECH, formerly manager of the annealing and fettling departments of Messrs. Hadfields, Limited, East Hecla Works, Sheffield, died recently, aged 69.

EX-BAILIE JAMES HAMILTON, who died on December 8, was 82 years of age, and retired from the employ of Messrs. Lobnitz & Company, Limited, Renfrew, in 1929, after 50 years' service.

MR. ROBERT FRASER, of Arbroath, died recently. Mr. Fraser, who was 80 years of age, was a son of the late Mr. Douglas Fraser, founder of the ironfounding and engineering firm of Douglas Fraser & Sons, Limited, Arbroath.

MR. ROBERT HOUSTON, who died at Kirn on December 10, at the age of 79, was for 47 years in the employ of Messrs. Stewarts and Lloyds, Limited, and at the time of his retirement a few years ago was manager of the Imperial Tube Works.

WHILE WALKING TO HIS WORK at Port Downie Iron Works of Messrs. Walker Hunter & Company, Limited, Falkirk, last Monday, Mr. Peter Smillie, a 68-year-old moulder, was seen to stagger and fall unconscious. He was conveyed to his home by motor-car, but died a few minutes after arrival.

## Forthcoming Events

### Institute of British Foundrymen

DECEMBER 21.

*Lancashire Branch (Junior Section)*:—"Cupola Practice." Paper by J. Jackson, at the College of Technology, Sackville Street, Manchester, at 7.30 p.m.

*Sheffield and District Branch*:—"Further Notes on Defects in Steel Castings." Paper by C. H. Kain, at the Grand Hotel, Sheffield, at 7.45 p.m.

# Sterling

## UP-TO-DATE MOULDING BOX EQUIPMENT.

### STERLING ROLLED STEEL MOULDING BOXES

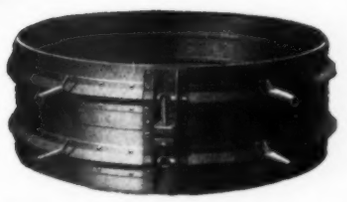
have been designed for THE MODERN FOUNDRY.

They are light and easy to handle.
Cannot crack or break.
Cannot spring.
Strong, Rigid, Durable and Permanently accurate.

### BY ADOPTING STERLING BOXES IN YOUR FOUNDRY,

You will halve your moulding costs. You will increase production per man per hour, and reduce your box maintenance costs. You will turn out more accurate castings and thereby reduce your scrap and reject accounts. You will considerably reduce your fettling costs and put money into your pocket that is now running to waste.

STERLING BOXES save their cost in a few months and are obviously a sound investment for any foundry.



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*Agents at:*—London, Manchester, Newcastle-on-Tyne and Glasgow.

BEDFORD.

# Raw Material Markets

Activity in the iron and steel markets has lessened on the approach of the holiday, but the contraction has been less noticeable than in recent years. Producers of pig-iron have every reason to be satisfied with their position so far as orders are concerned, being already heavily booked over the first quarter of 1935.

## Pig-Iron

**MIDDLESBROUGH.**—Activity in the Cleveland iron market has lessened, as is customary at this period of the year. There has, however, been quite a number of inquiries circulating for forward contracts. Delivery specifications against current contracts have also come along very well. The negotiating of forward contracts is hampered by the possibility of an advance in prices coming into operation in the New Year. For the time being, however, there is no change, fixed prices of No. 3 Cleveland G.M.B. for home delivery being:—Middlesbrough area, 67s. 6d. per ton; North-East Coast, 69s. 6d.; Falkirk area, 67s. 3d.; Glasgow area, 70s. 3d. No. 1 is at the usual premium of 2s. 6d. per ton, and 1s. per ton discount is allowed on No. 4 foundry and No. 4 forge.

Heavy forward sales of East Coast hematite have been made over the first quarter of next year, principally to Sheffield and Midlands consumers. Sales in some cases extend to the end of the half-year. Export trade is also looking up, although prices are still unremunerative as compared with those obtainable in the home trade. For delivery in the Middlesbrough area, No. 1 East Coast hematite is quoted at 69s. per ton, mixed numbers being 6d. per ton cheaper. Quotations for delivery in other zones remain unchanged.

**LANCASHIRE.**—Very few fresh orders for pig-iron have been received in this area during the past week. Many consumers have already contracted for a large part of their requirements over the first quarter. There has been no change in the price position. For delivery to users in the Lancashire district, values of Staffordshire and Derbyshire brands of No. 3 foundry iron are quoted on the basis of 74s. per ton, with Northamptonshire at 72s. 6d., Derbyshire forge iron at 69s. to approved consumers, Scottish foundry at around 82s. 6d., East Coast hematite at from 75s. to 76s. per ton, according to quality, and West Coast at about 78s. 6d.

**MIDLANDS.**—The demand for pig-iron has slowed down with the approach of the holidays, but a full resumption of activities is expected in January. The furnaces have plentiful stocks of No. 3 iron, both in Northants and Derbyshire, and no price changes are anticipated. The controlled prices for Midland brands of No. 3 iron, which include delivery to Birmingham and the Black Country stations, are 67s. 6d. for Northants and 71s. for Derbyshire, Lincolnshire and North Staffordshire iron. Special refined pig-iron for engine and similar work is offered at £5 7s. 6d. to £6 10s. per ton. Low-phosphorus iron and Scottish No. 3 are offered at 85s. 6d. to 87s. 6d., while the figures for medium-phosphorus irons range from 72s. 6d. to 80s., delivered this district.

**SCOTLAND.**—The demand for Scottish foundry iron has quietened down. The official minimum of 70s. per ton f.o.t. furnaces for No. 3 is still in force, with 2s. 6d. extra for No. 1. The Falkirk and district founders have remained very busy, and this continues to be a good market for Cleveland iron.

## Coke

No change is observable in the cupola-coke market. New business has been largely confined to small parcels, the majority of users being well covered. Current quotations for delivery in the Birmingham area are 36s. to 40s. per ton for best Durham fuel, 35s. to 45s. for Welsh coke, and 40s. per ton for Scottish coke.

## Steel

As far as the steel trade is concerned, the outlook for 1935 is quite promising. Manufacturers of semi-finished steel are quite well booked over the first quarter, and the volume of business going to Continental works in this type of material has been considerably reduced. The output of finished steel during December has been heavy. Several shipbuilding orders recently placed offer a promise of increased business in plates, etc., and the initiation of the Government's subsidy scheme for shipping is also expected to prove beneficial.

## Scrap

In the Cleveland district there has been a steady demand for foundry cast-iron scrap at 52s. 6d. per ton, delivered. Machinery metal remains at 53s. 6d. There is a steady demand for cast-iron scrap in the Midlands at unchanged prices. Recent reports from South Wales have indicated a rather better demand for heavy cast iron, which is quoted at upwards of 50s. per ton, but there is only a limited call for machinery grade in foundry sizes at about 55s. In Scotland there have been some odd sales of machinery scrap at 56s. 6d. to 57s. 6d., according to destination, with ordinary cast iron around 51s. 3d. to 52s. 6d. per ton.

## Metals

**Copper.**—The demand for base metals has fallen off with the approach of the holiday period, and activity in the copper trade has declined accordingly. Consumers have also been less inclined to make purchases by reason of the advent of the stock-taking period. The most interesting factor in the market situation is the possibility of an international agreement being arrived at between the producers, who are to meet in New York early in the New Year. It is suggested unofficially that the agreement will provide for curtailment of outputs, allocation of markets and fixed price minima, but the latter proviso is a rather doubtful possibility, in view of the failure of Copper Exporters, Inc., in the same direction. It is stated that stocks of copper in this country are now above 50,000 tons.

Daily market prices:—

*Cash.*—Thursday, £27 17s. 6d. to £28; Friday, £28 1s. 3d. to £28 2s. 6d.; Monday, £28 6s. 3d. to £28 7s. 6d.; Tuesday, £28 2s. 6d. to £28 5s.

*Three Months.*—Thursday, £28 6s. 3d. to £28 7s. 6d.; Friday, £28 8s. 9d. to £28 10s.; Monday, £28 15s. to £28 16s. 3d.; Tuesday, £28 11s. 3d. to £28 12s. 6d.

**Tin.**—There has been little change in the tin situation on the London market, the price of standard metal still fluctuating within very narrow limits. The premium asked for Straits tin is now in the region of £2 per ton.

It is interesting to note that the chairman of a prominent Malayan tin-mining concern is reported as saying recently that his company could produce tin at a cost of about £60 per ton, and that a profit of £170 per ton was commercial robbery. These, of course, are exceptional figures as compared with the majority of mines.

Price fluctuations:—

*Cash.*—Thursday, £228 10s. to £228 12s. 6d.; Friday, £228 5s. to £228 10s.; Monday, £228 5s. to £228 7s. 6d.; Tuesday, £228 to £228 2s. 6d.

*Three Months.*—Thursday, £228 10s. to £228 15s.; Friday, £228 10s. to £228 15s.; Monday, £228 10s. to £228 12s. 6d.; Tuesday, £228 10s. to £228 12s. 6d.

**Spelter.**—Dealing in the zinc market has been slack, and is not expected to recover for a week or so. There has been quite a fair demand for spelter recently from the consuming trades, activity in certain sections of the galvanising trade having picked up.

Day-to-day quotations:—

*Ordinary.*—Thursday, £11 13s. 9d.; Friday, £11 12s. 6d.; Monday, £11 13s. 9d.; Tuesday, £11 11s. 3d.

**Lead.**—"There has been a falling off in demand, which is quite usual at this time of the year, and which is largely of a technical nature. It is interesting to note that the directors of Australian mines now feel that, even with the advantage of the exchange rate, their profits are in danger of disappearing. It looks as if an effort will be made by producers in the not too distant future to arrive at some understanding in order to obtain better prices. In America the price has been raised to 3.60 cents," report Messrs. Brandeis, Goldschmidt.

Price fluctuations have been as follow:—

*Soft Foreign (Prompt).*—Thursday, £10 5s.; Friday, £10 5s.; Monday, £10 5s.; Tuesday, £10 2s. 6d.

## Patent Specifications Accepted

*The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.*

415,066. HERAEUS-VACUUMSCHMELZE AKT.-GES., and ROHN, DR. W. Production of beryllium alloys.

415,067. EUMUCO AKT.-GES. FÜR MASCHINENBAU, and SCHNEIDER, A. Hydraulic press for bending sheet metal.

415,321. KRUPP GRUSONWERK AKT.-GES., F. Roller for roller mills.

415,375. MILLS, LIMITED, Executors of J., and MACBETH, A. Fastenings for securing railway rails to metal sleepers.

415,384. CHEMIEPRODUKTE GES. Corrosion-resisting coverings for pipes and other articles.

415,409. SIEMENS-SCHUCKERTWERKE AKT.-GES. Extruded metal tubes and extrusion presses for producing such tubes, for example, lead sheaths for cables.

415,423. BIRMINGHAM ELECTRIC FURNACES, LIMITED, and LOBLEY, A. G. Annealing and other heat-treatment furnaces.

415,425. BAINES, C. W., and STANTON IRONWORKS COMPANY, LIMITED. Pipe joints.

415,428. GENERAL ELECTRIC COMPANY, LIMITED, and CAPLAN, M. C. Process for annealing alloys.

415,433. SMALLWOOD, A., and FALLON, J. Conveyance of goods through furnaces and the like.

415,452. LUKE & SPENCER, LIMITED, and CRITCHLEY, H. Surface-grinding machines.

415,485. AUDLEY ENGINEERING COMPANY, LIMITED, WYNN, E. W., and LEACH, K. M. Cast iron.

415,518. BROWN, G. D., and MATTHEWS, R. K. Apparatus for cutting white-metal bearings.

415,542. BERYLLIUM CORPORATION. Beryllium or alloys thereof, and a process of fusing the same.

## The Engineering Properties of Cast Iron

(*Concluded from page* 386.)

costly additions. The answer, however, which he thought was quite convincing, was that already some five or six foundries have been set up in this country for making nothing else but special and alloy cast irons. This can only lead to the conclusion that in the long run the alloy irons are an economic proposition. With regard to the question of increased strength on vibration, the author suggested that this was a case of ageing by relief of casting stresses. The use of special irons and alloy additions, incidentally, frequently tended to give castings which were more uniform and were freer from such stresses. Under these circumstances it is not surprising that such special irons should show higher strengths and greater stability in service.

A MEMBER reported that he had been making some hard castings for grinding applications in which he has used a proportion of steel scrap in the cupola, the castings giving an ultimate carbon content of 2.5 per cent. The castings had proved brittle and unusable and had broken to pieces in service. He asked Dr. Everest what his opinion was as to the cause of the trouble.

DR. EVEREST stated that he felt that a carbon of 2.5 was too low for cast iron. In the high-test irons a figure of 2.75 was considered ideal, but 3 per cent. was nearer the figure usually recommended for general castings. The figure of 2.5 per cent. suggested not only brittle metal but also metal which would probably be burnt due to oxidising conditions in the cupola.

MR. R. J. RICHARDSON, in proposing a vote of thanks to Dr. Everest, said that he had felt that those in the steel trade were in for a hard time. He thanked the lecturer for a very interesting and helpful lecture. MR. R. G. WILLIAMS seconded this and DR. EVEREST suitably responded.

# BRITISH ROLL FOUNDRIES

*Alongside*—
POURING A 10-TON ROLL in the Foundry of—

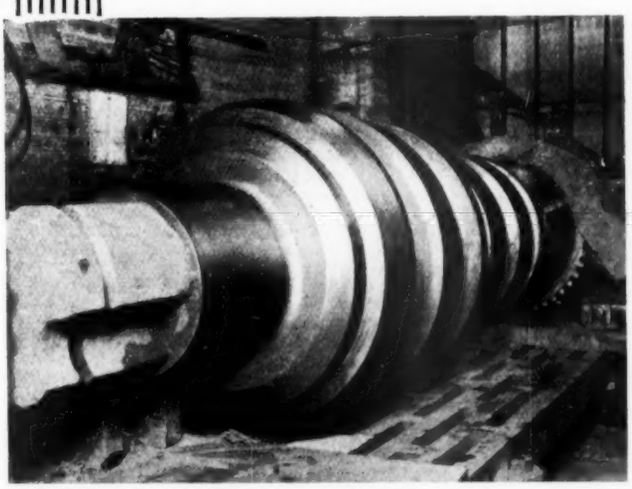
**Messrs. JOHNSONS IRON & STEEL CO., LTD.,**

**HALL END IRON WORKS, WEST BROMWICH,**

**Makers of Chilled & Grain Rolls and General Mill and Forge Castings**

**This firm — like so many others—always keep a stock of genuine Cold-Blast Pig Iron. They use it in most of their castings and the better the quality required, the more Cold Blast Iron they put in.**

*Below*—
A 14-ton Grooved Grain Roll in the Lathe. One of a pair for rolling 10" × 4½" beams. Necks 19" diam. Maximum collar diameter 41¼". Made at HALL END IRON WORKS.



**GENUINE COLD BLAST PIG IRON IS THE BEST FOR CHILLED CASTINGS AND HIGH GRADE ENGINEERING WORK**

***Brands :—***

**"DUD·L.N.F.'ces·DUD"** —*Makers:* THE EARL OF DUDLEY'S ROUND OAK WORKS, LTD., BRIERLEY HILL.

**"GRAZEBROOK"** —*Makers:* M. & W. GRAZEBROOK, LTD., DUDLEY, WORC.

**"LOWMOOR C.B."** —*Makers:* THE LOW MOOR IRON CO., LTD., NEW WORKS, LOW MOOR, YORKS.

# RAW MATERIALS—PRICE LIST

(Tuesday, December 18, 1934)

## COPPER

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 28 | 2 | 6 |
| Three months | 28 | 11 | 3 |
| Electrolytic | 31 | 10 | 0 |
| Tough | 30 | 5 | 0 |
| Best selected | 30 | 15 | 0 |
| Sheets | 58 | 0 | 0 |
| India | 41 | 10 | 0 |
| Wire bars | 31 | 15 | 0 |
| Ingot bars | 31 | 15 | 0 |
| H.C. wire rods | 34 | 10 | 0 |
| Off. av. cash, November | 27 | 5 | $5\frac{35}{44}$ |
| Do., 3 mths., November | 27 | 12 | $0\frac{9}{44}$ |
| Do., Sttlmnt., November | 27 | 5 | $5\frac{5}{11}$ |
| Do., Electro, November | 30 | 10 | $4\frac{17}{22}$ |
| Do., B.S., November | 30 | 3 | $7\frac{1}{5}$ |
| Do., wire bars, November | 30 | 16 | $4\frac{8}{11}$ |
| Solid drawn tubes | | | 9½d. |
| Brazed tubes | | | 9½d. |
| Wire | | | 6d. |

## BRASS

| | |
|---|---|
| Solid drawn tubes | 8½d. |
| Brazed tubes | 10½d. |
| Rods, drawn | 8d. |
| Rods, extd. or rlld. | 4½d. |
| Sheets to 10 w.g. | 7d. |
| Wire | 7d. |
| Rolled metal | 6½d. |
| Yellow metal rods | 4½d. |
| Do. 4 × 4 Squares | 5½d. |
| Do. 4 × 3 Sheets | 5½d. |

## TIN

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 228 | 0 | 0 |
| Three months | 228 | 10 | 0 |
| English | 228 | 2 | 6 |
| Bars | 230 | 2 | 6 |
| Straits | 230 | 5 | 0 |
| Australian (nom.) | — | | |
| Eastern | 231 | 0 | 0 |
| Banca (nom.) | 230 | 0 | 0 |
| Off. av. cash, November | 228 | 13 | $4\frac{10}{11}$ |
| Do., 3 mths., November | 228 | 16 | $0\frac{3}{11}$ |
| Do., Sttlmt., November | 228 | 13 | $10\frac{7}{11}$ |

## SPELTER

| | £ | s. | d. |
|---|---|---|---|
| Ordinary | 11 | 11 | 3 |
| Remelted | 12 | 15 | 0 |
| Hard | 10 | 5 | 0 |
| Electro 99.9 | 14 | 3 | 9 |
| English | 12 | 15 | 0 |
| India | 11 | 15 | 0 |
| Zinc dust | 17 | 0 | 0 |
| Zinc ashes | 3 | 0 | 0 |
| Off. aver., November | 12 | 2 | 9¾ |
| Aver. spot, November | 12 | 0 | 0 |

## LEAD

| | £ | s. | d. |
|---|---|---|---|
| Soft foreign ppt. | 10 | 2 | 6 |
| Empire (nom.) | 11 | 7 | 6 |
| English | 12 | 5 | 0 |
| Off. average, November | 10 | 10 | $3\frac{9}{22}$ |
| Average spot, November | 10 | 8 | $7\frac{7}{11}$ |

## ALUMINIUM

| | |
|---|---|
| Ingots | £100 to £105 |
| Wire | 1/1 to 1/9 lb. |
| Sheet and foil | 1/2 to 2/9 lb. |

## ZINC SHEETS, &c.

| | £ | s. | d. |
|---|---|---|---|
| Zinc sheets, English | 23 | 10 | 0 |
| Do., V.M. ex-whse. | 23 | 0 | 0 |
| Rods | 26 | 10 | 0 |

## ANTIMONY

| | £ | s. | d. |
|---|---|---|---|
| English | 75 | 0 | 0 |
| Chinese, ex-whse. | 65 | 0 | 0 |
| Crude | — | | |

## QUICKSILVER

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Quicksilver | 11 | 2 | 6 | to | 11 | 10 | 0 |

## FERRO-ALLOYS AND STEEL-MAKING METALS

| | |
|---|---|
| Ferro-silicon— | |
| 25% | £8 17 6 |
| 45/50% | £13 0 0 |
| 75% | £18 7 6 |
| Ferro-vanadium— | |
| 35 50 | 12/8 lb. Va. |
| Ferro-molybdenum— | |
| 70/75% carbon-free | 5/3 lb. Mo. |
| Ferro-titanium— | |
| 23/25% carbon-free | 9d. lb. |
| Ferro-phosphorus, 20/25% | £14 10 0 |
| Ferro-tungsten— | |
| 80/85% | 3/– lb. |
| Tungsten metal powder— | |
| 98/99% | 3/3 lb. |
| Ferro-chrome— | |
| 2/4% car. | £29 15 0 |
| 4/6% car. | £23 0 0 |
| 6/8% car. | £21 12 6 |
| 8/10% car. | £21 12 6 |
| Ferro-chrome— | |
| Max. 2% car. | £34 0 0 |
| Max. 1% car. | £38 15 0 |
| Max. 0.70% car. | £42 0 0 |
| 70% carbon-free | 10d. lb. |
| Nickel—99.5/100% | £200 to £205 |
| "F" nickel shot | £184 0 0 |
| Ferro-cobalt, 98/99% | 5/3 lb. |
| Metallic chromium— | |
| 96/98% | 2/5 lb. |
| Ferro-manganese (net)— | |
| 76/80% loose | £10 15 0 to £11 5 0 |
| 76/80% packed | £11 15 0 to £12 5 0 |
| 76/80% export (nom.) | £9 15 0 |
| Metallic manganese— | |
| 94/96% carbon-free | 1/2 lb. |

Per ton unless otherwise stated.

## HIGH-SPEED TOOL STEEL

| | |
|---|---|
| Finished bars, 14% tungsten | 2s. 0d. |
| Finished bars, 18% tungsten | 2s. 9d. |

Per lb. net, d/d buyers' works.

| Extras— | |
|---|---|
| Rounds and squares, 3 in. and over | 4d. lb. |
| Rounds and squares, under ½ in. to ¼ in. | 3d. lb. |
| Do., under ¼ in. to $\frac{1}{16}$ in. | 1/– lb. |
| Flats, ¼ in. × ¼ in. to under 1 in. × ⅜ in. | 3d. lb. |
| Do., under ¼ in. × ¼ in. | 1/– lb. |
| Bevels of approved sizes and sections | 6d. lb. |

Bars cut to length, 10% extra.

## SCRAP

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| South Wales— | | | | | | | |
| Heavy steel | 2 | 15 | 0 | to | 2 | 16 | 0 |
| Bundled shrngs. | | | | | 2 | 7 | 6 |
| Mixed iron and steel | 2 | 10 | 0 | to | 2 | 12 | 6 |
| Heavy cast iron | 2 | 10 | 0 | to | 2 | 12 | 6 |
| Good machinery | | | | | 2 | 15 | 0 |
| Cleveland— | | | | | | | |
| Heavy steel | 2 | 11 | 0 | to | 2 | 12 | 6 |
| Steel turnings | | | | | 1 | 15 | 0 |
| Cast-iron borings | | | | | 1 | 5 | 0 |
| Heavy cast iron | | | | | 2 | 12 | 6 |
| Heavy machinery | | | | | 2 | 13 | 6 |
| Midlands— | | | | | | | |
| Light cast-iron scrap | | | | | 2 | 7 | 6 |
| Heavy-wrought iron | | | | | 3 | 0 | 0 |
| Steel turnings, f.o.r. | | | | | 1 | 14 | 0 |
| Scotland— | | | | | | | |
| Heavy steel | | | | | 2 | 10 | 0 |
| Ordinary cast iron | 2 | 11 | 3 | to | 2 | 12 | 6 |
| Engineers' turnings | | | | | 1 | 19 | 0 |
| Cast-iron borings | | | | | 1 | 17 | 6 |
| Wrought-iron piling | | | | | 2 | 11 | 3 |
| Heavy machinery | | | | | 2 | 16 | 6 |

London—Merchants' buying prices, delivered yard.

| | £ | s. | d. |
|---|---|---|---|
| Copper (clean) | 24 | 0 | 0 |
| Brass | 16 | 0 | 0 |
| Lead (less usual draft) | 9 | 10 | 0 |
| Tea lead | 7 | 0 | 0 |
| Zinc | 8 | 10 | 0 |
| New aluminium cuttings | 66 | 0 | 0 |
| Braziery copper | 19 | 0 | 0 |
| Gunmetal | 22 | 0 | 0 |
| Hollow pewter | 155 | 0 | 0 |
| Shaped black pewter | 115 | 0 | 0 |

## PIG-IRON

| | |
|---|---|
| N.E. Coast (d/d Tees-side area)— | |
| Foundry No. 1 | 70/– |
| Foundry No. 3 | 67/6 |
| ,, at Falkirk | 67/3 |
| ,, at Glasgow | 70/3 |
| Foundry No. 4 | 66/6 |
| Forge No. 4 | 66/6 |
| Hematite No. 1 | 69/– |
| Hematite M/Nos. | 68/6 |
| N.W. Coast— | |
| Hem. M/Nos. d/d Glas. | 72/6 |
| ,, d/d Birm. | 84/6 |
| Malleable iron d/d Birm. | 115/– |
| Midlands (d/d Birmingham dist.)— | |
| Staffs No. 4 forge | 67/– |
| ,, No. 3 fdry. | 71/– |
| Northants forge | 63/6 |
| ,, fdry. No. 3 | 67/6 |
| ,, fdry. No. 1 | 70/6 |
| Derbyshire forge | 67/– |
| ,, fdry. No. 3 | 71/– |
| ,, fdry. No. 1 | 74/– |
| Scotland— | |
| Foundry No. 1, f.o.t. | 72/6 |
| ,, No. 3, f.o.t. | 70/– |
| Hem. M/Nos. d d | 71/– |
| Sheffield (d/d district)— | |
| Derby forge | 64/6 |
| ,, fdry. No. 3 | 68/6 |
| Lincs forge | 64/6 |
| ,, fdry. No. 3 | 68/6 |
| E.C. hematite | 81/6 |
| W.C. hematite | 83/6 |
| Lancashire (d/d eq. Man.)— | |
| Derby fdry. No. 3 | 74/– |
| Staffs fdry. No. 3 | 74/– |
| Northants fdry. No. 3 | 72/6 |
| Cleveland fdry. No. 3 | 74/– |
| Dalzell, No. 3 (special) | 102/6 to 105/– |
| Glengarnock, No. 3 | 82/6 |
| Clyde, No. 3 | 82/6 |
| Monkland, No. 3 | 82/6 |
| Summerlee, No. 3 | 82/6 |
| Eglinton, No. 3 | 82/6 |
| Gartsherrie, No. 3 | 82/6 |
| Shotts, No. 3 | 82/6 |

## FINISHED IRON AND STEEL

*Usual district deliveries for iron; delivered consumer's station for steel.*

| Iron— | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Bars (cr.) | 9 | 12 | 6 | to | 9 | 15 | 0 |
| Nut and bolt iron | 7 | 10 | 0 | to | 8 | 0 | 0 |
| Hoops | 10 | 10 | 0 | and up. | | | |
| Marked bars (Staffs) f.o.t. | | | | 12 | 0 | 0 | |
| Gas strip | 10 | 10 | 0 | and up. | | | |
| Bolts and nuts, ¾ in. × 4 in. | 14 | 0 | 0 | and up. | | | |
| Steel— | | | | | | | |
| Plates, ship, etc. | 8 | 15 | 0 | to | 8 | 17 | 6 |
| Boiler plts. | 9 | 5 | 0 | to | 9 | 7 | 6 |
| Chequer plts. | | | | 10 | 7 | 6 | |
| Angles | | | | 8 | 7 | 6 | |
| Tees | | | | 9 | 7 | 6 | |
| Joists | | | | 8 | 15 | 0 | |
| Rounds and squares, 3 in. to 5½ in. | | | | 9 | 7 | 6 | |
| Rounds under 3 in. to ½ in. (Untested) | | | | 8 | 12 | 0 | |
| Flats—8 in. wide and over | | | | 8 | 12 | 6 | |
| ,, under 8 in. and over 5 in. | | | | 8 | 17 | 6 | |
| Rails, heavy | 8 | 5 | 0 | to | 8 | 10 | 0 |
| Fishplates | 12 | 5 | 0 | to | 12 | 10 | 0 |
| Hoops (Staffs) | | | | 9 | 7 | 0 | |
| Black sheets, 24g. (4-t. lots) | | | | 10 | 10 | 0 | |
| Galv. cor. shts. ( ,, ) | | | | 13 | 0 | 0 | |
| Galv. flat shts. ( ,, ) | | | | 13 | 10 | 0 | |
| Galv. fencing wire, 8g. plain | | | | 14 | 10 | 0 | |
| Billets, soft | 5 | 10 | 0 | and up. | | | |
| Billets, hard | 6 | 17 | 6 | to | 7 | 2 | 6 |
| Sheet bars | 5 | 0 | 0 | to | 5 | 7 | 6 |
| Tin bars | 5 | 2 | 6 | to | 5 | 7 | 6 |

## PHOSPHOR BRONZE

| | Per lb. basis. |
|---|---|
| Strip | 9d. |
| Sheet to 10 w.g. | 10d. |
| Wire | 11d. |
| Rods | 10d. |
| Tubes | 13d. |
| Castings | 10½d. |

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

## NICKEL SILVER, &c.

| | Per lb. |
|---|---|
| Ingots for raising | 7d. to 1/1 |
| Rolled— | |
| To 9 in. wide | 1/1 to 1/7 |
| To 12 in. wide | 1/1½ to 1/7½ |
| To 15 in. wide | 1/1½ to 1/7½ |
| To 18 in. wide | 1/2 to 1/8 |
| To 21 in. wide | 1/2½ to 1/8½ |
| To 25 in. wide | 1/3 to 1/9 |
| Ingots for spoons and forks | 7d. to 1/3½ |
| Ingots rolled to spoon size | 10d. to 1/6½ |
| Wire round— | |
| to 10g. | 1/4½ to 1/11½ |

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

## AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

| | Dols. |
|---|---|
| No. 2 foundry, Phila. | 20.26 |
| No. 2 foundry, Valley | 18.50 |
| No. 2 foundry, Birm. | 14.50 |
| Basic, Valley | 18.00 |
| Bessemer | 20.76 |
| Malleable, Valley | 18.50 |
| Grey forge, Valley | 18.00 |
| Ferro-mang. 80%, seaboard | 85.00 |
| O.-h. rails, h'y, at mill | 36.37½ |
| Billets | 27.00 |
| Sheet bars | 28.00 |
| Wire rods | 38.00 |
| | Cents. |
| Iron bars, Chicago | 1.80 |
| Steel bars | 1.80 |
| Tank plates | 1.80 |
| Beams, etc. | 1.80 |
| Skelp, grooved steel | 1.70 |
| Steel hoops | 2.10 |
| Sheets, black, No. 24 | 2.40 |
| Sheets, galv., No. 24 | 3.10 |
| Wire nails | 2.60 |
| Plain wire | 2.30 |
| Barbed wire, galv. | 3.00 |
| Tinplates, 100-lb. box | $5.25 |

## COKE (at ovens)

| | |
|---|---|
| Welsh foundry | 25/- to 30/- |
| ,, furnace | 19/- to 20/- |
| Durham foundry | 20/- to 25/- |
| ,, furnace | 17/6 |
| Midlands, foundry | — |
| ,, furnace | — |

## TINPLATES

f.o.b. Bristol Channel ports.

| | | | |
|---|---|---|---|
| I.C. cokes | 20×14 per box | | 18/2 to 18/6 |
| ,, | 28×20 | ,, | 36/4 to 37/– |
| ,, | 20×10 | ,, | 26/– to 26/3 |
| ,, | 18¾×14 | ,, | 18/6 to 18/9 |
| C.W. | 20×14 | ,, | 15/9 to 16/6 |
| ,, | 28×20 | ,, | 33/6 to 34/– |
| ,, | 20×10 | ,, | 23/9 to 24/– |
| ,, | 18¾×14 | ,, | 16/– |

## SWEDISH CHARCOAL IRON & STEEL

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Pig-iron | £6 | 0 | 0 | to | £7 | 0 | 0 |
| Bars-hammered, basis | £16 | 0 | 0 | to | £16 | 10 | 0 |
| Bars and nail-rods, rolled, basis | £15 | 15 | 0 | to | £16 | 0 | 0 |
| Blooms | £10 | 0 | 0 | to | £12 | 0 | 0 |
| Keg steel | £30 | 0 | 0 | to | £31 | 0 | 0 |
| Faggot steel | £18 | 0 | 0 | to | £23 | 0 | 0 |
| Bars and rods dead soft, st'l | £10 | 0 | 0 | to | £12 | 0 | 0 |

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

## DAILY FLUCTUATIONS

**Standard Copper** (cash)

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Dec. | 13 .. | 27 | 17 | 6 | inc. 3/9 |
| „ | 14 .. | 28 | 1 | 3 | „ 3/9 |
| „ | 17 .. | 28 | 6 | 3 | „ 5/- |
| „ | 18 .. | 28 | 2 | 6 | dec. 3/9 |

**Standard Tin** (cash)

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Dec. | 13 .. | 228 | 10 | 0 | No change |
| „ | 14 .. | 228 | 5 | 0 | dec. 5/- |
| „ | 17 .. | 228 | 5 | 0 | No change |
| „ | 18 .. | 228 | 0 | 0 | dec. 5/- |

**Spelter** (ordinary)

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Dec. | 13 .. | 11 | 13 | 9 | No change |
| „ | 14 .. | 11 | 12 | 6 | dec. 1/3 |
| „ | 17 .. | 11 | 13 | 9 | inc. 1/3 |
| „ | 18 .. | 11 | 11 | 3 | dec. 2/6 |

**Zinc Sheets** (English)

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Dec. | 13 .. | 23 | 10 | 0 | No change |
| „ | 14 .. | 23 | 10 | 0 | „ „ |
| „ | 17 .. | 23 | 10 | 0 | „ „ |
| „ | 18 .. | 23 | 10 | 0 | „ „ |

**Electrolytic Copper**

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Dec. | 13 .. | 31 | 0 | 0 | No change |
| „ | 14 .. | 31 | 5 | 0 | inc. 5/- |
| „ | 17 .. | 31 | 10 | 0 | „ 5/- |
| „ | 18 .. | 31 | 10 | 0 | No change |

**Tin** (English ingots)

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Dec. | 13 .. | 228 | 12 | 6 | No change |
| „ | 14 .. | 228 | 12 | 6 | „ „ |
| „ | 17 .. | 228 | 7 | 6 | dec. 5/- |
| „ | 18 .. | 228 | 2 | 6 | „ 5/- |

**Spelter** (Electro, 99.9 per cent.)

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Dec. | 13 .. | 14 | 6 | 3 | inc. 1/3 |
| „ | 14 .. | 14 | 5 | 0 | dec. 1/3 |
| „ | 17 .. | 14 | 6 | 3 | inc. 1/3 |
| „ | 18 .. | 14 | 3 | 9 | dec. 2/6 |

**Lead** (English)

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Dec. | 13 .. | 12 | 10 | 0 | No change |
| „ | 14 .. | 12 | 10 | 0 | „ „ |
| „ | 17 .. | 12 | 10 | 0 | „ „ |
| „ | 18 . | 12 | 5 | 0 | dec. 5/- |

## Imports and Exports of Pig-Iron, Iron and Steel Castings, etc., in November and the eleven months, 1934, compared with a year ago.

| | November. | | Eleven months. | | November. | | Eleven months. | |
|---|---|---|---|---|---|---|---|---|
| | 1933. | 1934. | 1933. | 1934. | 1933. | 1934. | 1933. | 1934. |
| | Tons. | Tons. | Tons. | Tons. | £ | £ | £ | £ |
| *Imports.* | | | | | | | | |
| Pig-iron, forge | — | — | — | — | — | — | — | — |
| „ foundry | 2,185 | 1,693 | 34,261 | 26,722 | 8,456 | 5,143 | 123,188 | 77,780 |
| „ acid | — | — | 37 | — | — | — | 226 | — |
| „ basic | 8,090 | 9,506 | 51,412 | 73,064 | 21,526 | 26,883 | 137,325 | 203,111 |
| Total (including other kinds) | 10,275 | 12,951 | 85,710 | 113,521 | 30,072 | 41,711 | 260,739 | 360,188 |
| Castings and forgings | 54 | 314 | 984 | 3,556 | 1,040 | 8,706 | 22,529 | 89,592 |
| Cast pipes and fittings | 267 | 66 | 1,306 | 973 | 3,895 | 2,130 | 25,832 | 49,757 |
| Stoves, grates, etc. | 42 | 119 | 728 | 1,095 | 3,206 | 7,033 | 56,463 | 86,858 |
| Baths | 1,678 | 557 | 7,823 | 7,212 | 37,282 | 14,818 | 180,037 | 180,377 |
| Hollow-ware, all kinds | 339 | 196 | 2,541 | 2,115 | 14,169 | 12,281 | 100,992 | 123,138 |
| *Exports.* | | | | | | | | |
| Pig-iron, forge | 145 | 192 | 1,960 | 1,224 | 568 | 743 | 7,778 | 5,074 |
| „ foundry | 7,374 | 8,922 | 46,187 | 67,990 | 24,695 | 13,272 | 159,444 | 233,451 |
| „ acid | 6,459 | 4,260 | 47,759 | 43,352 | 20,091 | 13,411 | 148,796 | 136,850 |
| „ basic | 20 | 10 | 1,322 | 842 | 121 | 71 | 5,105 | 2,796 |
| Total | 13,998 | 13,384 | 97,228 | 113,408 | 45,475 | 45,497 | 321,123 | 378,171 |
| Castings and forgings | 287 | 571 | 2,513 | 5,105 | 10,433 | 21,164 | 102,419 | 197,691 |
| Cast pipes and fittings, up to 6 in. diameter | 5,521 | 5,842 | 46,847 | 56,793 | 55,591 | 64,020 | 519,722 | 630,877 |
| „ „ „ over 6 in. „ | 4,946 | 2,824 | 31,546 | 34,233 | 39,185 | 22,995 | 232,800 | 257,015 |
| Stoves, grates, etc. | 711 | 863 | 6,236 | 8,105 | 38,900 | 46,394 | 307,266 | 396,015 |
| Sanitary cisterns | 296 | 237 | 2,497 | 2,776 | 8,568 | 7,054 | 73,109 | 80,573 |
| Bedsteads, inc. tubes therefor | 376 | 413 | 3,730 | 4,440 | 14,213 | 14,751 | 135,073 | 151,112 |
| Cast hollow-ware | 401 | 393 | 3,920 | 3,458 | 16,185 | 15,072 | 154,927 | 132,304 |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ZETLAND ROAD, MIDDLESBROUGH.

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STEEL-FOUNDRY Chemist and Metallurgist desires change. Also had steelworks experience. Thorough knowledge electric-furnace practice, alloy steels, heat-treatment. (252)

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20-Ton Stevenson.
16-Ton Stevenson.
15-Ton Stevenson.
12-Ton Evans.
10-Ton Evans.
8-Ton Evans.
6-Ton Evans.
5-Ton Evans.

Forty smaller Ladles in Stock.

A. HAMMOND,
Foundry Machinery Merchant, Slough.

3½-TON Brackelsberg Rotary Furnace, complete with equipment, equal to new. Above lying at Lowmoor Foundry.—Communicate with ALEX. HAMMOND, Foundry Machinery Merchant, Slough.

### MACHINERY—*Continued*

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NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

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Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

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Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

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Index to Advertisers, p. 9. Situations, etc., p. 14.

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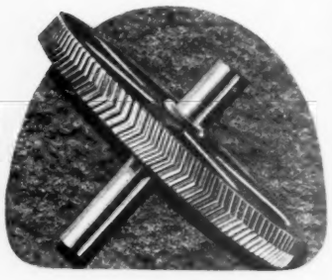
## REFINED PIG IRON



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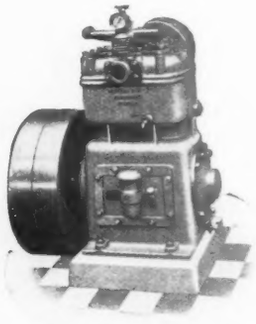
## & DRY VACUUM PUMPS

VERTICAL SINGLE-ACTING TYPE.



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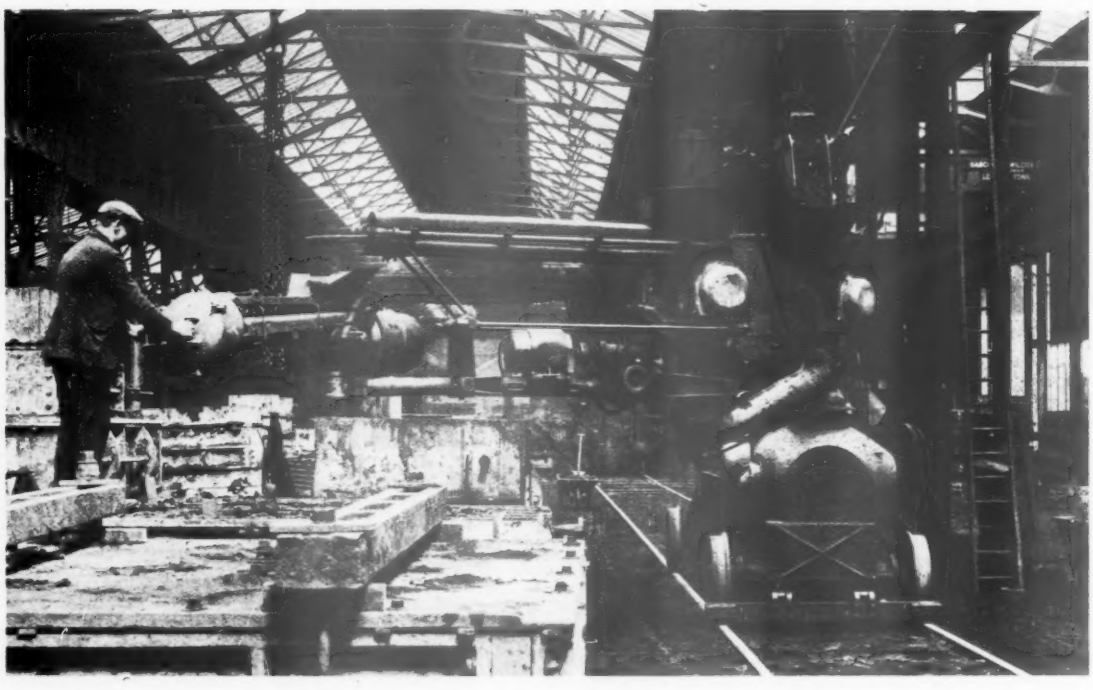

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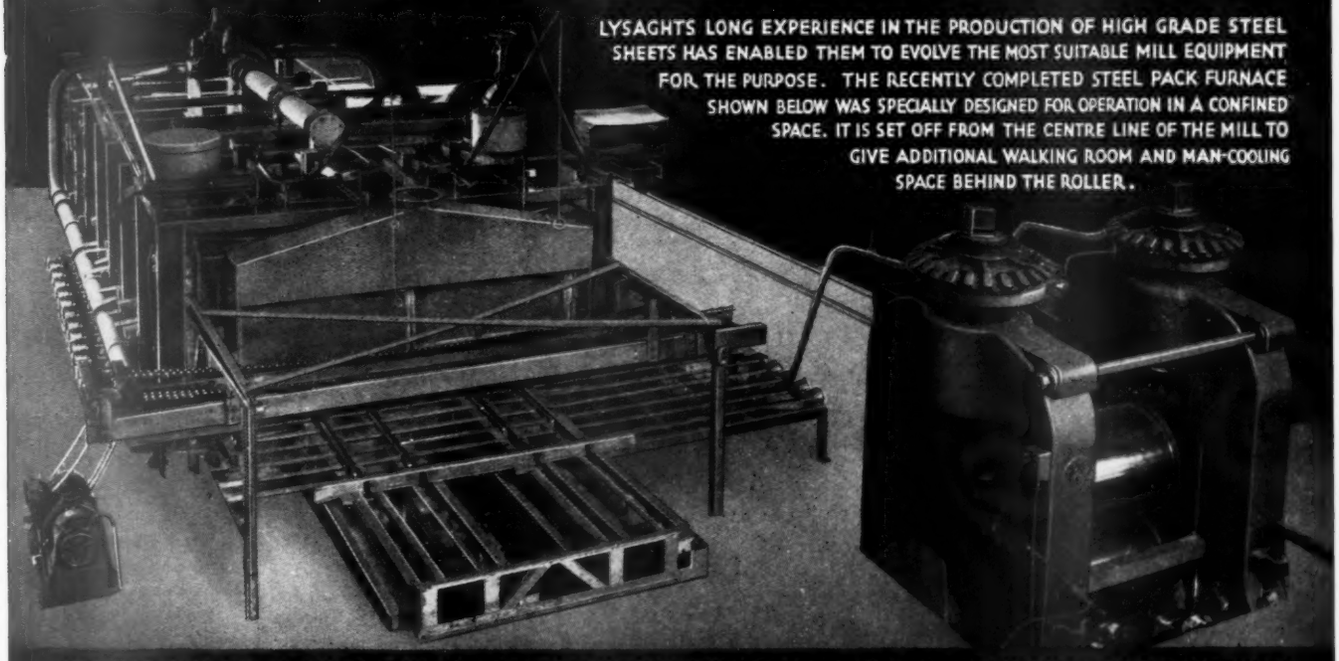

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## INDEX TO ADVERTISERS.


| | PAGE |
|---|---|
| Acheson, E. G., Ltd. | — |
| Aerograph Co., Ltd. | — |
| Alldays & Onions, Ltd. | — |
| Allen, T. Fearnley, & Son | 17 |
| Amalgams Co., Ltd., The | — |
| Armstrong, Whitworth, Sir W. G., & Co. (Engineers), Ltd. | — |
| Armstrong, Whitworth, Sir W. G., & Co. (Ironfounders), Ltd. | — |
| Atlas Preservative Co., Ltd. | — |
| August's, Ltd. | 10 |
| Baker, Perkins, Ltd. | — |
| Baldwins, Ltd. | 4 |
| Barrow Hæmatite Steel Co., Ltd., The | 15 |
| Baxter, W. H., Ltd. | — |
| Bradley & Foster, Ltd. | — |
| British Aluminium Co., Ltd. | — |
| British (Guest Keen Baldwins) Iron & Steel Co., Ltd., The | — |
| British Oxygen Co., Ltd. | — |
| British Pigirons, Ltd. | — |
| British Rema Manufacturing Co., Ltd., The | — |
| British Reverberatory Furnaces, Ltd. | — |
| British Thomson-Houston Co., Ltd. | — |
| Butterworth Bros., Ltd. | 18 |
| Carborundum Co., Ltd., The | — |
| Colvilles, Ltd. | 11 |
| Consett Iron Co., Ltd. | 3 |
| Controlled Heat & Air Ltd. | — |
| Crane Chemical (The Fredk.), Co., Ltd. | — |
| Cumming, Wm., & Co., Ltd. | — |
| Davidson & Co., Ltd. | — |
| Distington Hematite Iron Co., Ltd., The | — |
| Dudley's Round Oak Works Ltd., Earl of | — |
| Durrans, J., & Sons, Ltd. | 17 |
| Electromagnets, Ltd. | — |
| Eyre Smelting Co., Ltd., The | — |
| Findlay, A., & Co., Ltd. | 18 |
| Fordath Engineering Co., Ltd. | 2 |
| Foundry & Engineering Co. (West Bromwich), Ltd. | — |
| Foundry Equipment, Ltd. | — |
| Foundry Plant & Machinery, Ltd. | 6 |
| Foundry Services, Ltd. | 15 |
| Fox & Offord, Ltd. | — |
| Gadd, Thos. | — |
| General Electric Co., Ltd. | — |
| General Refractories, Ltd. | 1 & 8 |
| Gibbons (Dudley), Ltd. | — |
| Giesserei, Die | — |
| Gossell & Son, Ltd. | 19 |
| Gray, J., & Sons, Ltd. | 11 |
| Gray, Thos. E., & Co., Ltd. | — |
| Grayson, J., Lowood, & Co., Ltd. | — |
| Grazebrook, M. & W., Ltd. | — |
| Green, George, & Co. | — |
| Hammond, Alex. | 14 |
| Harper, Wm., Son & Co. (Willenhall), Ltd. | — |
| Hawkins, W. T., & Co. | 4 |
| Herbert, Alfred, Ltd. | — |
| Imperial Chemical Industries, Ltd. | — |
| International Smelters, Ltd. | — |
| Jackman, J. W., & Co., Ltd. | — |
| Jacks, William, & Co. | 13 |
| James, Wm. | — |
| Keith, James, & Blackman Co., Ltd. | — |
| King Bros. (Stourbridge), Ltd. | — |
| Knowles, John, & Co. (Wooden Box), Ltd. | — |
| Lancashire Steel Corporation, Ltd. | 7 |
| Le Personne, L., & Co. | 1 |
| Lilleshall Co., Ltd. | 19 |
| Longden, G., & Son, Ltd. | — |
| Lord, E. S., Ltd. | — |
| Low Moor Iron Co., Ltd., The | — |
| Lowood, J. Grayson, & Co., Ltd. | — |
| Lysaght, John, Ltd. | 9 |
| Macdonald, John, & Co. (Pneumatic Tools), Ltd. | 18 |
| Major, Robinson & Co., Ltd. | — |
| Metropolitan-Vickers Electrical Co., Ltd. | — |
| Mond Nickel Co., Ltd., The | — |
| Morgan Crucible Co., Ltd., The | — |
| Morris, Herbert, Ltd. | — |
| Mowat's Pioneer Grit Co., Ltd. | — |
| Neild, G. | — |
| Norton Grinding Wheel Co., Ltd. | — |
| Notcutt, Walter P., Ltd. | — |
| Olsen, Wm., Ltd. | — |
| Parish, J., & Co. | — |
| Park Gate Iron & Steel Co. | — |
| Paterson Hughes Engineering Co., Ltd. | — |
| Pearson, E. J. & J., Ltd. | — |
| Phillips, J. W. & C. J., Ltd. | — |
| Pickard, W., & Co., Ltd. | — |
| Pickford, Holland & Co., Ltd. | — |
| Pitman, Sir Isaac & Sons, Ltd. | 15 |
| Pneulec, Ltd. | — |
| Portway, C., & Sons | — |
| Precision Presswork Co. | — |
| Price, J. T., & Co., Ltd. | — |
| Pulzer, S., & Son, Ltd. | — |
| Purimachos, Ltd. | — |
| Quest Products, Ltd. | — |
| Reavell & Co., Ltd. | 4 |
| Richardson, R. J., & Sons, Ltd. | — |
| Ritchie, J. & R., Ltd. | 11 |
| Roper, E., & Co. | — |
| Rotary Furnaces, Ltd. | — |
| St. George's Engineers Ltd. | — |
| Sankey, J., & Sons, Ltd. | — |
| Scottish Tar Distillers, Ltd. | — |
| Sheepbridge Coal & Iron Co., Ltd. | — |
| Shotts Iron Co., Ltd., The | — |
| Smarts Dinas Silica Brick Co., Ltd. | 18 |
| Smeeton, John A., Ltd. | 1 |
| Smith, Albert, & Co. | — |
| Smith, Edward, Ltd. | 18 |
| Smooth-On Mfg. Co. | — |
| Sommerfield, H. G., Ltd. | 18 |
| Spermolin, Ltd. | 5 |
| Stanton Ironworks Co., Ltd., The | 4 |
| Staveley Coal & Iron Co., Ltd. | — |
| Stein & Atkinson, Ltd. | 19 |
| Stein, J. G., & Co., Ltd. | 1 |
| Sterling Foundry Specialties, Ltd. | — |
| Sterling Manufacturing Co. | — |
| Stewarts and Lloyds, Ltd. | 20 |
| Tallis, E., & Sons | — |
| Tennent, R. B., Ltd. | 18 |
| Tilghman's Air Compressor Co. | — |
| Tilghman's Patent Sand Blast Co., Ltd. | — |
| United Steel Companies, Ltd., The | — |
| Vickers-Armstrong, Ltd. | — |
| Walker, I. & I. | — |
| Ward, Thos. W., Ltd. | 14 |
| Waring Bros. | — |
| Warner & Co., Ltd. | — |
| Watson's (Metallurgists), Ltd. | 15 |
| West Midland Refining Co., Ltd. | — |
| Wild Barfield Furnaces, Ltd. | 1 |
| Wilkinson, Thos., & Co., Ltd. | 4 |
| Willson Products, Inc. | — |
| Winnall, G., & Son | — |
| Woodward Bros. & Copelin, Ltd. | — |
| Workington Iron & Steel Co. (Branch of The United Steel Companies, Ltd.) | — |
| Zimmermann Machines | — |

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